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Engineering News-Record

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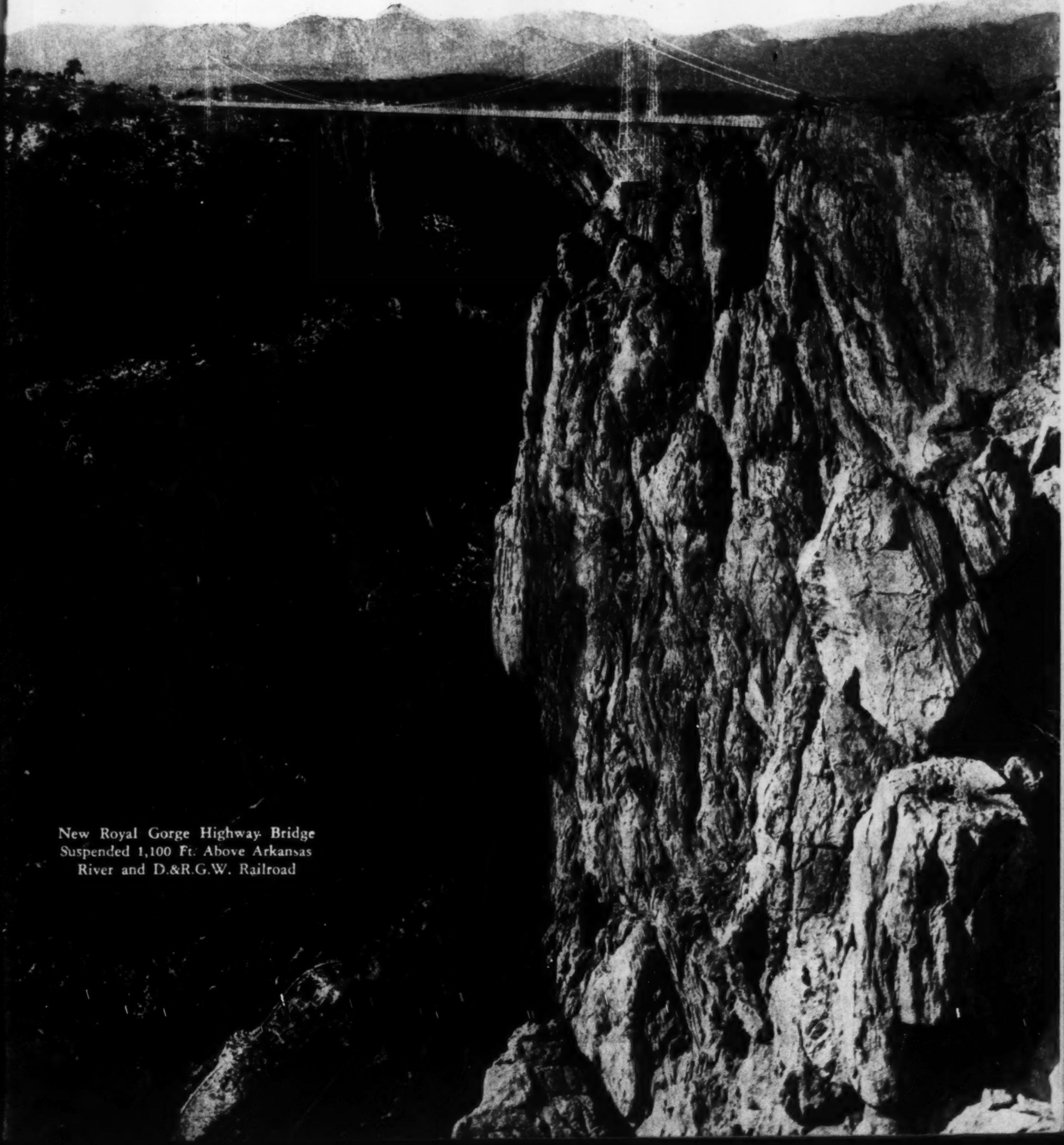

New Royal Gorge Highway Bridge
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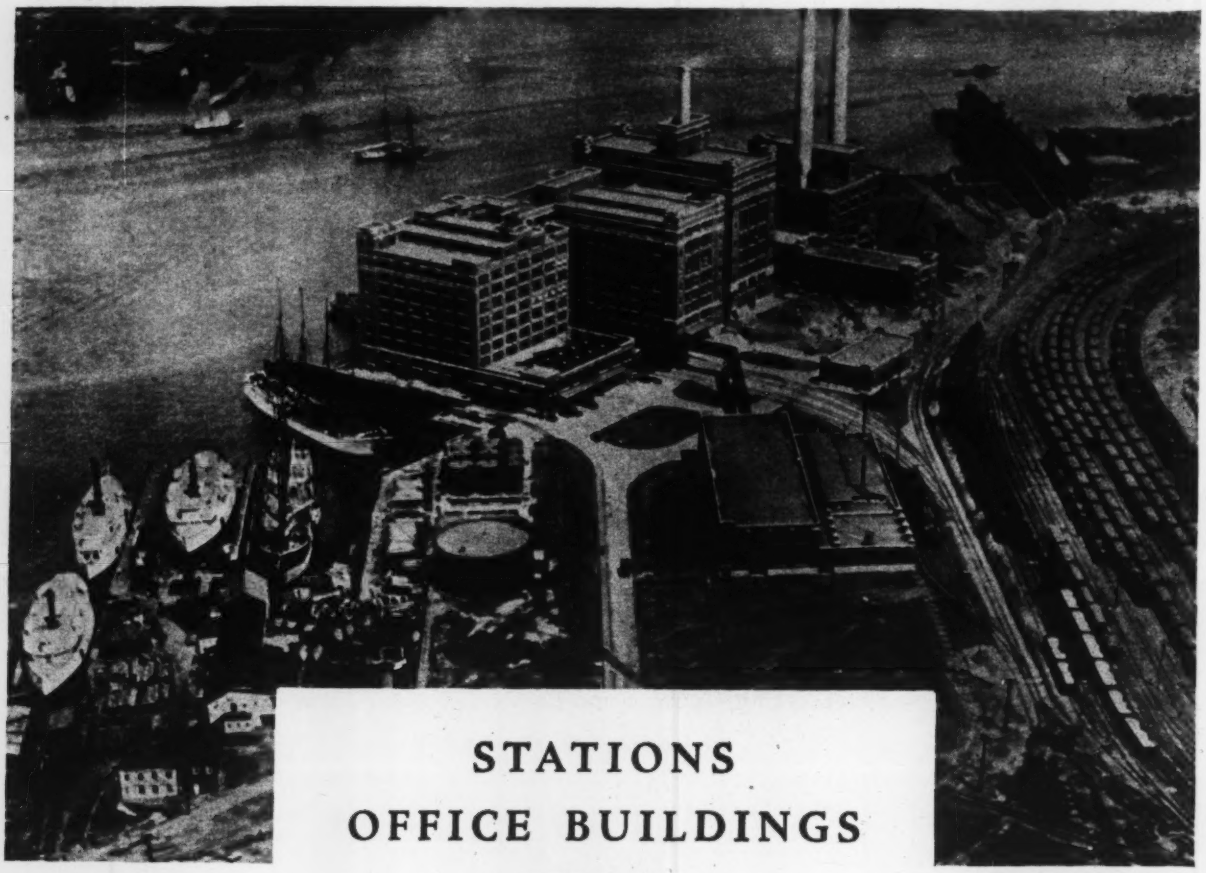

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

F. E. SCHMITT, *Editor*

Volume 104 NEW YORK, JUNE 5, 1930 Number 23

Traffic Problems Growing

WHILE street and road congestion is under intensive study by a nationwide committee, local action on the problem is less promising, in many instances. Control of traffic is generally intrusted to the police authorities, and not everywhere do these authorities appreciate the intricacy of the situation or the need for applying to it engineering data and the trained thinking of specialists. In one large city the police department has had a traffic engineer on its staff but is now threatening to abolish the office and revert to dependence on main-strength methods of police officers—clearly a backward step. Traffic problems are serious enough now, but they are growing more involved with every passing day, and the necessity for competent agencies to study traffic engineering is not lessening but is steadily increasing. Evidence of this is the backward state of traffic handling in some of the largest as well as in some of the smallest communities.

A Connecticut River Finding

ONE step of progress in the sharp controversies over water-supply use of Delaware and Connecticut river tributaries was made two weeks ago when the master appointed by the Supreme Court to hear the suit of Connecticut against Massachusetts made a finding in favor of Massachusetts—that is, in favor of the use of floodwaters of the Ware and Swift rivers to supply Boston. His findings enter deeply into the dominating theme of the respective rights of the two states. Connecticut's claim to undiminished flow of the river, and its demand for an injunction regardless of damage, are denied, on the ground that they are without merit. The master proceeded to examine specific claims of damage; his detail discussion of these matters is interesting, but only as a detail. The weight of the finding rests in its statement that equality of right between the two states controls the case. If the Supreme Court upholds its master in affirming this principle, many disputes over interstate waters will be simplified. The finding helps to clear the air.

The Public a Partner

UNDER modern conditions the public is frequently if not always a partner with engineer and promoter in putting through large enterprises of construction. Municipal projects are usually subject to bond-issue referendum, and, as repeated experiences have demonstrated, the vote in such a referendum often fails because of public apathy due to lack of information. Where a well-planned campaign of public education has been carried on in preparation for the referendum, its results have always been fair and decisive, whether for or against the proposition. In San Francisco the Golden Gate bridge project is expected to come to referendum vote late this summer—a decision of large proportions. Preparatory to this election the San Francisco *Call* is working to stir public interest through straw ballots for or against the project. Present returns point to popular approval; it will be interesting to check this result by the outcome of the actual election. But at all events the advance agitation will be of service in focusing public attention on the facts of the enterprise, its cost and its value. The more the public can be made to think on its engineering questions, the more intelligently will it act and the better will be its understanding of the engineer's problems.

Temporary Structures

AGAIN the collapse of a temporary timber grandstand illustrates the complete inadequacy of design, construction, supervision and permission of such structures. This time it was a reviewing stand at a Memorial Day parade in Chicago that failed—fortunately without casualties, but with considerable discomfort to the governor and a group of military and other officials. Structures of this sort are built frequently without any real design and by men who have no comprehension of the factors of loads, stresses and crowd action. In many cases failure is precipitated by the dynamic action of a stamping, swaying or rushing crowd. But at Chicago the reviewing stand could not even carry its static load, as the occupants were seated or standing, quietly watching the parade. Not to the builders belongs the primary blame, supposing their craftsmanship to be reasonably competent and well done. It belongs rather to their employers and to the other authorities which require or permit such structures to be erected without competent design or supervision.

Culvert Engineering

AT THE risk of adding a new variety to the long list of special departments of civil engineering activity we venture to suggest that the engineering of culvert design and construction is entitled to fuller attention than it has so far received. On the record of past performances, culverts are likely to be judged highly uncertain and perishable constructions. The account this week of how some pipe culverts failed before the road over them was completed tends to add force to such an impression. If part of the trouble here may be charged to neglect of foundation requirements—and this has always been a large factor in unsatisfactory behavior of engineering structures—another part is due to imperfect knowledge of load distribution in earth. A great contribution to better knowledge of the latter subject was made by the studies of Marston, whose major findings distinguish sharply between yielding and rigid culverts and show that the former are subject to less load than the latter. With these studies as a starting point, more specific analysis of culvert design and proper construction methods can be undertaken. One of its phases is field observation and rating of existing culverts, as already begun in some states and set forth in Searcy B. Slack's summary.

But the engineering study has considerably farther than this to go if it is to be fully useful. If carried to logical conclusion its results should enable the constructor to use each type of culvert structure efficiently, to adapt his selection to the conditions of the case, and to build with sureness.

Topsoil for Fill Slopes

THE unsightly appearance of rockfill slopes in highway cuts and fills often mars an attractive landscape like a great scar. This is particularly true of a road or canal built along a side hill just above a community long accustomed to the undisturbed natural beauty of the hill. When the cut is made the hill is gashed and left with the permanent disfigurement of a barren rockfill slope. A layer of topsoil distributed over the surface of such a fill will remain in place and will be sufficient to support a growth of native shrubs; even trees will thrive on the slope of a rockfill if topsoil covering enables them to get a start. Trees near the upper edge of the fill in a bench cut, when viewed from the plane below, will screen the bare slope on the hill side of the bench, and the scars of both cut and fill may thus be concealed. If regularity in distribution is avoided, the planting may approach Nature. Now that there is a widespread movement toward highway beautification, finished appearance has become more important, and scenic values put upon the engineer a direct obligation to make his road, canal or railway construction sightly. The cost of the topsoil has probably been the most common deterrent to proper planting and finishing; if care is taken to save the topsoil before the main excavation is begun, it can later be spread over the fill at little cost, and planting then involves no material expense. Ugliness is poor advertisement for the engineer's works.

Inspiring Counsel

A REMARKABLE picture of the present-day professional situation was sketched recently in a notable public address. We quote a few sentences: "It is plain that as a profession we do not enjoy the degree of public confidence of which we aspire to be worthy . . . No section of any community has so much class conscience and so little class consciousness, but certainly none has done so little by organized effort for its own improvement and the betterment of its service to the public." These are strong words. They voice thoughts that have been expressed as definitely, if less forcefully, in many private discussions among engineers. But let us read farther: "No other group is going through such a drastic economic evolution . . . So far as it is a desirable evolution it can no more be halted while there is the pressure of need behind it than a glacier can be stopped while its propelling pressure remains . . . The problem is essentially one of meeting and overcoming competition. We must so improve our service, so elevate its quality and increase its value, as to get and hold the business. Our only salvation will be found in service of a quality and value such as no one else can render." The man behind these words was Justice Roger A. Stone, of the Supreme Court of the United States, speaking to the American Law Institute on the plight of the legal profession. Had a leading engineer used the same words in addressing one of our great engineering societies, we would read them with the conviction that a spokesman of progress through sound ideals had come among us. Even though they come from a jurist, they may be taken to heart alike by the young engineer just receiving his graduation honors and by his brother of ripened experience.

Economies in Consolidation

MANY people in recent weeks have raised the question whether or not real economies were to be obtained through railroad consolidations. They asked whether consolidation is not simply a device for bringing profit to those more interested in the manipulation of railroad securities than in the economies which come through more efficient operation. The answer, in part at least, seems to lie in the opposition of railway labor organizations to consolidation plans, an opposition which has found support in the Couzens resolution now being considered by the House. That resolution, as written, states: "The commission is specifically authorized and directed to prescribe in its order approving and authorizing any consolidation or acquisition of control such terms and conditions as may be necessary to prevent the dismissal or demotion of employees, reduction of employment and/or uncompensated losses of rights, privileges and conditions of employment, and/or to compensate employees for all losses and expenses (including losses or expenses sustained through change of residence, or disposition of homes or other real property), as a result of the anticipation or consummation of such consolidation or acquisition of control." The reduction of labor costs is the chief source of economy in railroad operation. Forty-three cents of every dollar earned by the railroad goes to pay labor, and consequently it is through a reduction in labor costs by elimination of duplicate facilities and staffs or abandonment of obsolete facilities and rearrangement of engine districts and operating divisions that the greatest economies from consolidation are brought about. The concern of the railroad labor organizations over the effect of such changes as an outgrowth of consolidations shows that there still are numerous possibilities for economies through combined operations. Curiously enough Congress, by putting a check upon the dismissal or transfer of employees due to consolidations, will effectively check the very consolidations which can best show that they are something other than manipulations for the benefit of the manipulators only.

Notable Highway Safety Work

TESTIMONY to the wide interest in safety of travel on highways was given last week in Washington by the meeting of some 600 men on the call of Secretary of Commerce Robert P. Lamont, in the third Conference on Street and Highway Safety. Under the urge of a strong address by President Hoover, who as secretary of commerce sponsored the conferences of 1924 and 1926, the delegates vigorously reviewed and revised the committee work of the previous conferences and considered additional reports on railway grade crossings, motor-vehicle maintenance and traffic congestion. As the result of the two days' labor there now stand the completely revised four acts of the uniform vehicle code and an amended municipal traffic ordinance. The ordinances are now ready for adoption and enforcement.

Can efforts as vigorous be put into this latter task? Here is a distinct challenge to the highway industry. The conference has done its work. It was not created and is not organized to carry on in another activity. This task must be taken up by roadbuilding associations, the automotive industry, engineering organizations, chambers of commerce and accident prevention interests. If their delegates and the delegates of the railways, who worked so well on the conference committees and on the floor of the convention a week ago, will carry their enthusiasm back to the home organizations great results may be expected.

But there is even a greater demand on the roadbuilding associations to come forward and take a hand in the work, which they have consistently neglected or else recognized only in publicity gestures. It is not particularly creditable to roadbuilding associations, either official or commercial, that the name of not one was printed among the railway, automobile, insurance, vehicle operating and commercial associations which sponsored and financed the constructive highway safety work carried forward last week. Not a civil engineering society or a contracting association had group activity in the conference work. They, with the highway bodies, can redeem themselves by energetic action in promoting the enactment of the codes and ordinances into official regulations.

Simplifying Terminology

SPECIFICATIONS and descriptions of works dealing with water refer to flow rates in confusingly diverse ways. Are they necessary? A large filter plant will be rated at so many million gallons per day (often abbreviated m.g.d.), a pump in terms of gallons per minute (g.p.m.), and the discharge of the pipe line in cubic feet per second (sec.-ft.; sometimes c.f.s.). These different terms, all expressing in the last analysis the same thing, inevitably mean slow understanding, annoyance, confusion and need for conversion factors. They take their toll in lost time, unnecessary computation and arithmetical errors. One term should suffice for all uses. The most general is second-feet.

Confusing diversity in terminology is found not only in connection with rates of discharge but also in derived quantities. Unit rates of filtration are given in terms of million gallons daily per acre, gallons per square foot per minute, and feet drop per day. The last-mentioned has the merit of maximum simplicity, for after all it is a velocity that is being expressed.

Filter-plant chemists and water analysts have inherited a cumbersome legacy from the apothecary in their terminology of hardness, alkalinity and other chemical measures of water quality. When coagulating or softening chemicals are used, the dosage is most frequently defined in grains per gallon. But application of chlorine is on the basis of pounds per million gallons, and the residual chlorine in the treated water is reported in parts per million. And now comes hydrogen-ion concentration, awing the typesetter with the symbol pH as a measure of the hydrogen acidity of the water.

Akin to the bewildering synonyms for hydraulic and chemical units are the terms used to describe the physical characteristics of sand. Effective size and uniformity coefficient, with their lawyer-like definitions, were developed during a study of the flow of water through slow filters. Although slow sand filters have lost their popularity and have been succeeded by rapid filters with stratified sand beds and relatively high velocities of flow, the old terminology is still used.

Unfortunately, inefficiency accompanies annoyance as the result of this confusion, for terminology and notation have a value far beyond mere convenience. The Roman system of numbers was an obstacle too great to be overcome by the scholars of old; development of mathematics and exact science awaited the facility of computation made possible by the Arabic notation. In the same way, many of the older water analysts, accustomed to grains per gallon, had to learn the parts-per-million notation before they were able to make real use of the literature of water-softening—a large, unfortunate delay.

Simplification of our system of units in water practice is a very present need. The historical reasons which brought certain now obsolete terms and units into use have largely been outlived, and in the light of present-day demands an agreement on logical, efficient terminology and notation is both possible and necessary. The subject is worthy of consideration by technical societies.

For Efficiency in Building

WHOEVER has become well acquainted with building problems is familiar with the bewildering variety, complexity and conflict of building laws. Most of this confusion seems illogical; some of it doubtless is so, though many apparent conflicts are supported by a reason. But if building is to be simplified and made truly economical, we need simplified and rationalized laws. What is the way toward this end? Prof. W. K. Hatt in his exposition of the Building Code Committee work indicates the answer.

Nearly ten years have passed since the start of the ambitious work to bring greater harmony and uniformity into building codes—the work to which the late Ira H. Woolson gave so much devotion and energetic labor. It is difficult to get an adequate perspective of this undertaking, and correspondingly difficult to appraise it fairly and foretell its future possibilities. Professor Hatt removes this difficulty by outlining the work as a whole.

Adequate understanding of this code-drafting work should serve most powerfully to gain support for the efforts of the Building Code Committee, heretofore not received as widely or enthusiastically as it deserves to be. So much patient study, so much knowledge of building, so much sound judgment, have been applied by the committee as to make its product an authoritative comparison standard in any building-code question.

When the work was begun it had less obvious possibilities than it has today, for building has increased in volume and has evolved in variety of types and materials. Greater need exists today than existed ten years ago for a uniform standard to govern the major elements of building design and construction. It is true that differences in climate, in markets, in human habits, even in craftsmanship, may fairly be urged as justification for variations in code requirements; but we believe that uniformity will pay dividends far surpassing any minor savings that could be made by variation. If this be true, the all-round interests of the building fraternity, no less than those of the public at large, wait upon active prosecution of the committee's work.

The field to be covered is large, almost appallingly large, and up to now the committee has considered only part. Completion of the work at the present rate of progress will postpone the final result longer than is desirable. Can it be expedited? It can, we believe, by fuller organization embracing more active participation of technical and craft organizations. Whatever means may be suitable, the work is worth speeding up if that can be accomplished without lowering its quality. Its early success is essential to efficiency and economy in building.

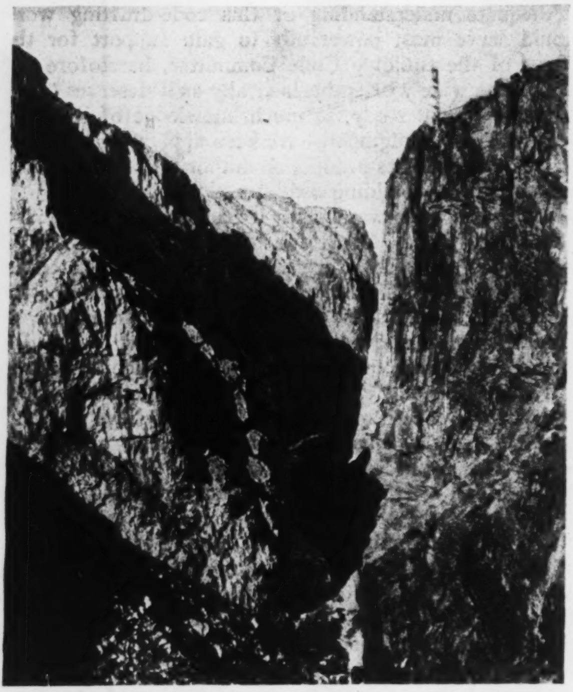
New Suspension Bridge Spans Royal Gorge in Colorado

Roadway of Structure With 880-Ft. Main Span Is More Than 1,000 Ft. Above the River—Design Includes Novel Anchorages of Vertically Embedded Pipes—Cradled Main Cables, Special Wind Cables and Staggered Floor System Joints Resist Wind Pressure

By George E. Cole
Bridge Contractor, Houston, Tex.

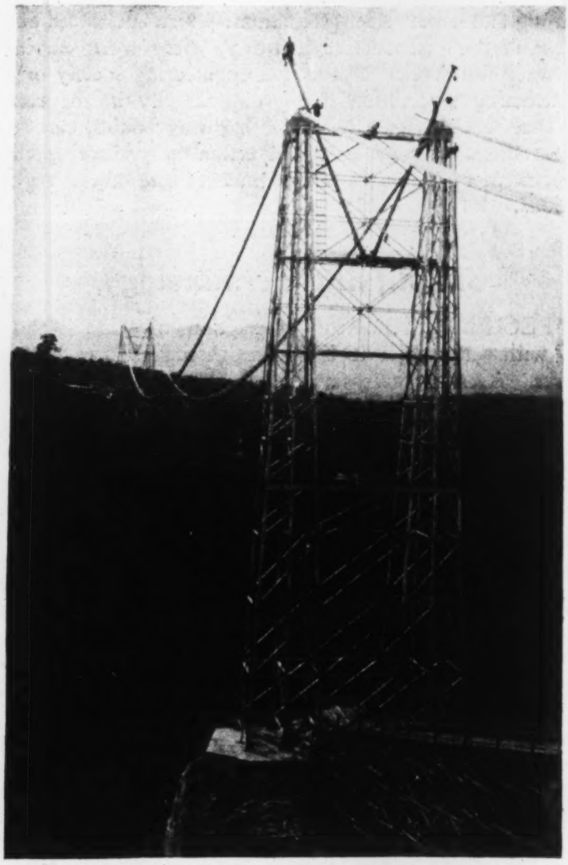
The Author of this article, George E. Cole, who designed and built the Royal Gorge suspension bridge, was connected with the Midland Bridge Co., of Kansas City, Mo., for eighteen years. Mr. Cole has also built three other bridges for the same capitalist that promoted the Royal Gorge bridge, these former bridges spanning the Rio Grande between Texas and New Mexico. —Editor.

The Royal Gorge suspension bridge, which was opened to traffic on Dec. 8, 1929, involves several unusual features in its design and construction. It first is unique as being located higher above the river than any other bridge yet built—1,053 ft. above the tracks of the Denver & Rio Grande Western Railroad, which follows the canyon wall only a few feet above high water. It has a main suspended span of 880 ft. and a total length of 1,200 ft. A width of only 18 ft. and the fact that no stiffening trusses are used make it necessary to use wind cables and to cradle the main cables. A novel anchorage involving a series of pipes, set upright in a trench in the rock face of the canyon, is a feature of the design. A special telescoping traveler, operating on the cables, was a feature of the erection work. No footwalks were used in the construction of the bridge.



NEW ROYAL GORGE BRIDGE IS LOCATED 1,053 FT. ABOVE THE ARKANSAS RIVER AND THE TRACKS OF THE D.&R.G.W.R.R.

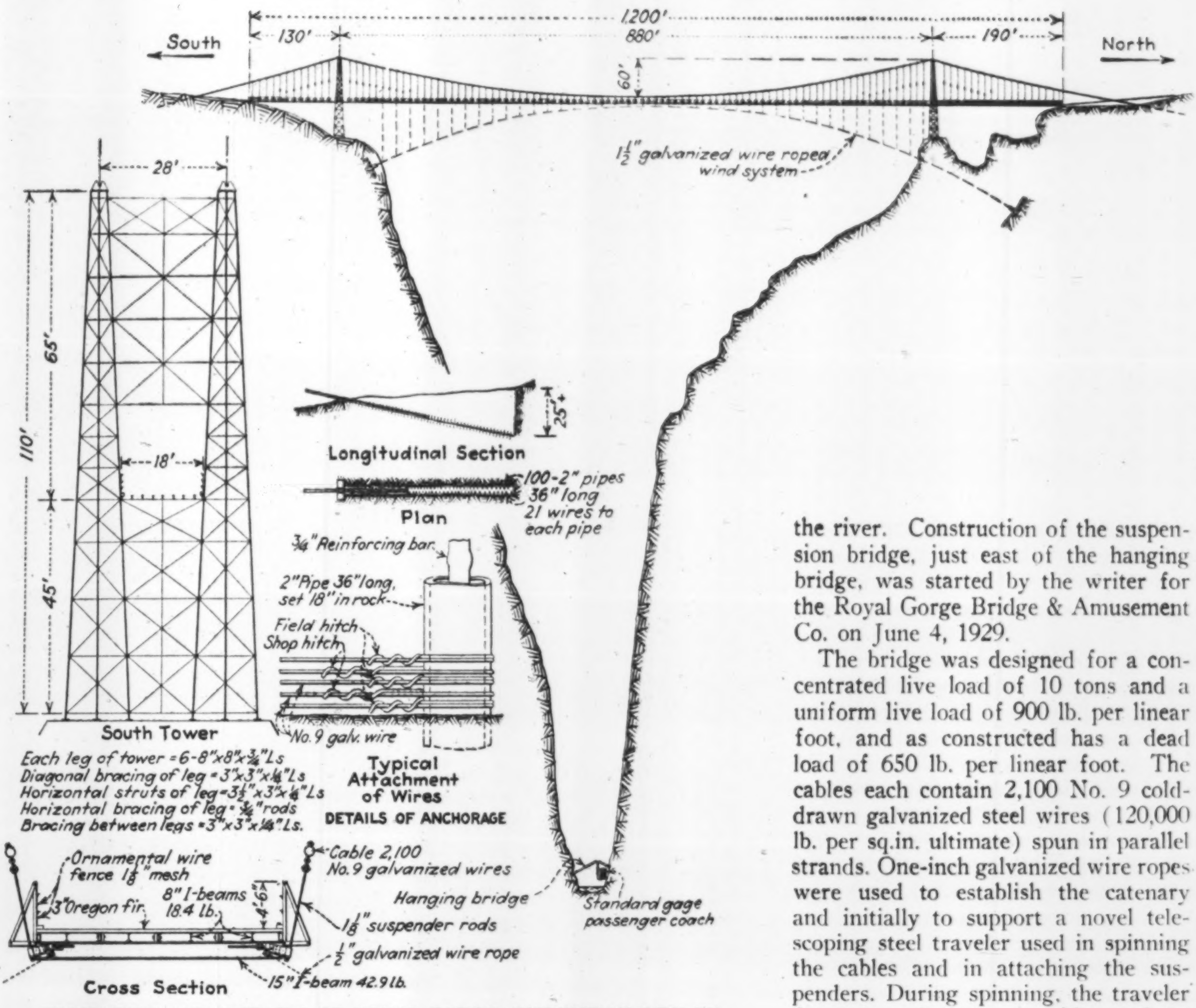
The telescoping traveler used in spinning the cables and in attaching the suspenders may be seen in the center of the span.



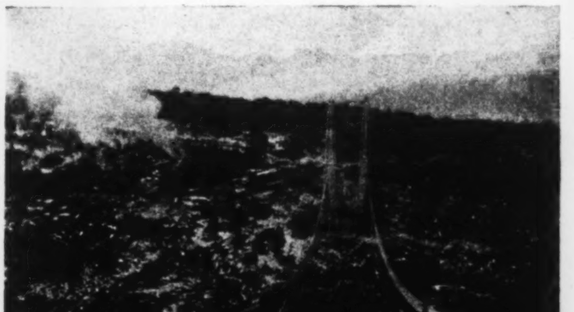
SPINNING THE WIRE CABLES, ROYAL GORGE BRIDGE

Staging in the right foreground affords support for haulage rope, which may be seen hanging across the canyon. Wires were pulled across with this rope, after which they were lifted vertically to the saddles by means of hand-operated derricks on top of the towers.

The rugged canyon of the Arkansas River, known as the Royal Gorge, is located 6 miles (via the Denver & Rio Grande Western Railroad) west from Canon City, Colo., and about 47 miles west of Pueblo. The canyon is traversed by the main line of the Denver & Rio Grande Western Railroad, which, at the narrowest point, is carried along the side of the canyon wall by the famous hanging bridge designed by C. Shaler Smith and built by the railroad in 1878. For many years an automobile highway has extended to the rim of the gorge, but until the construction of the suspension bridge the terminus of this highway was at a point opposite the hanging bridge and some 1,100 ft. vertically above


1,200'
130'
880'
190'
South
North
60'
1½" galvanized wire roped wind system
28'
110'
65'
18'
45'
South Tower
Each leg of tower = 6-8"x8"x¾" Ls
Diagonal bracing of leg = 3"x3"x¼" Ls
Horizontal struts of leg = 3½"x3"x¼" Ls
Horizontal bracing of leg = ¾" rods
Bracing between legs = 3"x3"x¼" Ls.
25'±
Longitudinal Section
100-2" pipes 36" long 21 wires to each pipe
Plan
¾" Reinforcing bar
2" Pipe 36" long, set 18" in rock
Field hitch
Shop hitch
No. 9 galv. wire
Typical Attachment of Wires
DETAILS OF ANCHORAGE
Ornamental wire fence 1⅛" mesh
3" Oregon fir
8" I-beams 18.4 lb.
4'-6"
Cable 2,100 No. 9 galvanized wires
Hanging bridge
1⅛" suspender rods
½" galvanized wire rope
15" I-beam 42.9 lb.
Cross Section
Standard gage passenger coach

ELEVATION AND DETAILS OF ROYAL GORGE SUSPENSION BRIDGE



TELESCOPING TRAVELER BEING USED TO ATTACH A HANGER ROD

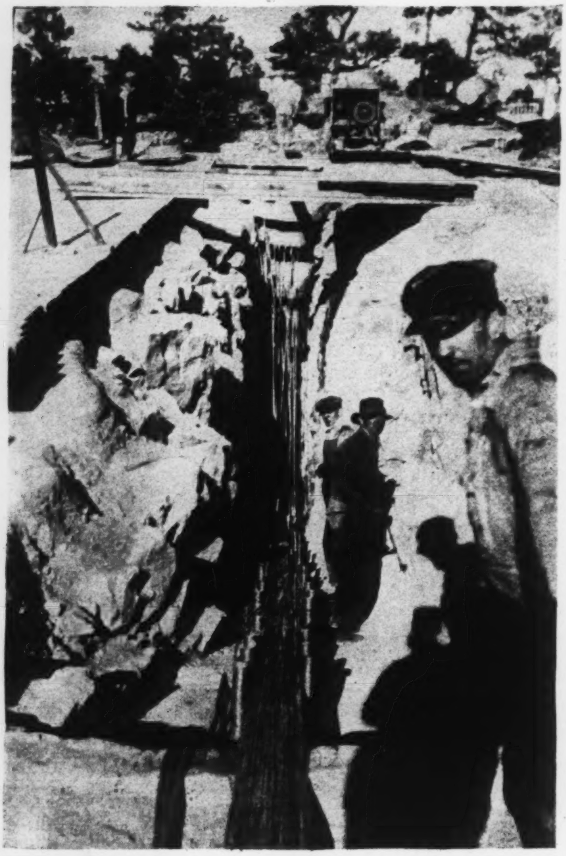
the river. Construction of the suspension bridge, just east of the hanging bridge, was started by the writer for the Royal Gorge Bridge & Amusement Co. on June 4, 1929.

The bridge was designed for a concentrated live load of 10 tons and a uniform live load of 900 lb. per linear foot, and as constructed has a dead load of 650 lb. per linear foot. The cables each contain 2,100 No. 9 cold-drawn galvanized steel wires (120,000 lb. per sq.in. ultimate) spun in parallel strands. One-inch galvanized wire ropes were used to establish the catenary and initially to support a novel telescoping steel traveler used in spinning the cables and in attaching the suspenders. During spinning, the traveler formed a platform at midspan from which workmen adjusted sag in the wires. The traveler moved on sheaves having 9-in. grooves, enabling it to operate over the finished cables. Cradling of the cables from 28-ft. centers at the towers to 21 ft. centers at the middle of the span made necessary the telescoping feature of the traveler.

The tower legs are constructed of six 8x8x¾-in. angles surmounted by cast-steel saddles, each weighing 4,000 lb., which rest on 5-in. steel rollers designed for a 9-in. travel, special conditions at this site making hinged towers impracticable. The south tower bent is 110 ft. high from the base to the center of the rollers, while the north tower bent, built on a projecting point of rock, has unequal legs, the longer of which is 150 ft. high.

The handling of the individual wires comprising the main cables was accomplished by means of power-drawn carriers operating over haulage cables, suspended along each side of the bridge. Twenty-five per cent of the wire was stored near each anchorage. Each reel, placed on a ball-bearing rotating table, equipped with suitable brake devices, was unwound as its wire was pulled across the canyon, and the previously prepared anchor loop was released from the carrier and deposited over its anchor pipe.

Hand-operated grab lines, dropped from each tower apex, lifted each wire over the saddles, and tension adjustments were then made in the following sequence: first, between the anchor pipe just mentioned and the adjacent tower; second, between this tower and midspan;

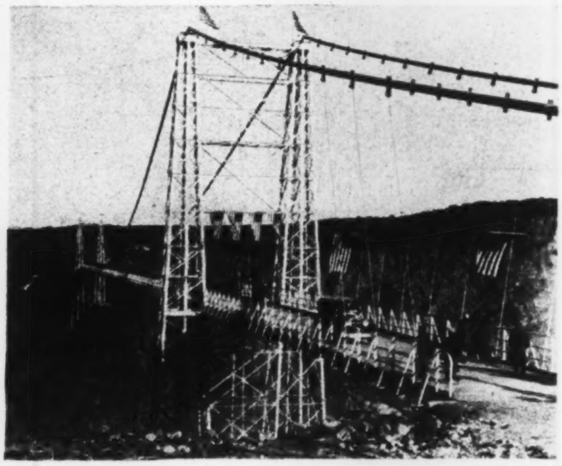


ANCHORING THE CABLE WIRES
The trench is 75 ft. long, and 21 wires are attached to each of the pipes.

third, between midspan and the second tower; and lastly, between the second tower and the final attachment to a pipe anchor. The 1-in. wire ropes, which were originally strung to the desired catenary, served as templets for the stringing of wire strands, and remained as the core of the finished cable.

Anchorage of the main cables constitutes an interesting feature of the structure. This was accomplished by first trenching the solid granite on the same inclination as the backstays for a distance of approximately 75 ft. and to a maximum depth of 25 ft. In the bottom of this rock trench, which was roughly 4 ft. wide, two lines of holes 18 in. apart were drilled to receive sections of 2-in. pipe 3 ft. long. There are 100 pipes grouted into each trench. After fastening 21 wires to each pipe, a ¾-in. reinforcing bar was inserted, and also grouted. These bars were allowed to extend approximately to the top of the trench. As a final operation, the trench was filled with concrete.

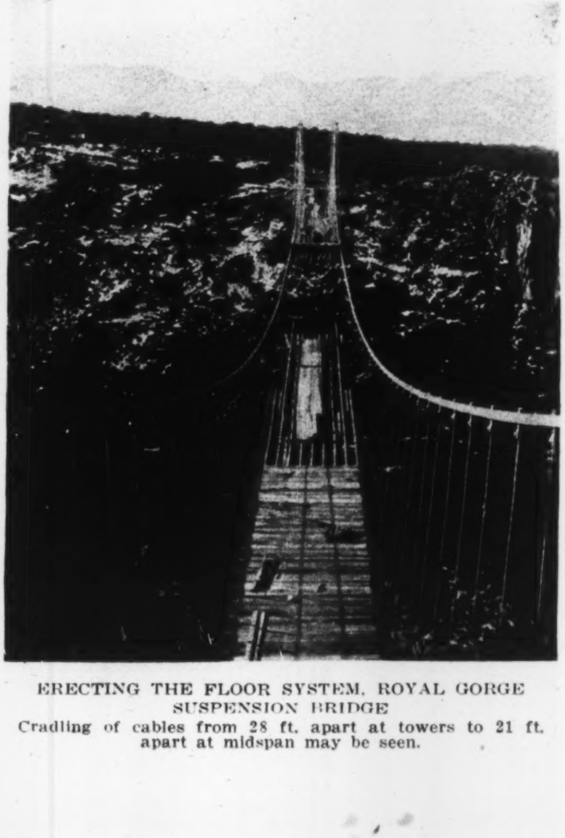
The floor system, which is suspended from the cables at 10-ft. panel points by 1⅛-in. steel suspender rods, consists of 15-in. floorbeams, which in turn support seven lines of 8-in. I-beams and two lines of 8-in. channel stringers. The channels are continuous over four panels, and staggered joints are used on the floorbeams to lend stiffness to the structure in lieu of stiffening trusses. Additional rigidity is provided by fences 4½ ft. high fabricated of steel angles and heavy close-meshed wire netting. The adjustment of the floor system is made by threading the lower upset section of the suspender rods. The floor is of 3-in. plank, the roadway being 18 ft. wide between handrails.



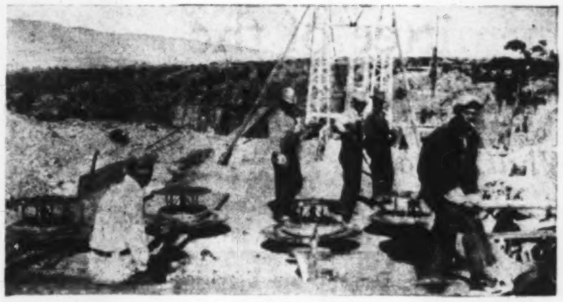
THE ROYAL GORGE BRIDGE ON THE DAY IT OPENED
The unequal legs of the north tower are visible across the canyon.

Wind cables consisting of 1½-in. galvanized-wire ropes are anchored to the canyon walls and ½-in. guys tie the bridge floor to the cables at 20-ft. intervals. Such cables were necessary in order to give the bridge added stability against the uplifting of the high winds prevalent in the canyon. The fastening of these wind cables to the canyon walls at points 100 ft. or more below the floor of the bridge and at distances greater than 100 ft. outside the bridge tangent constituted a unique feature of the construction.

As a part of the program of the owner, the writer is to build an incline railway from the bottom of the



ERECTING THE FLOOR SYSTEM, ROYAL GORGE SUSPENSION BRIDGE
Cradling of cables from 28 ft. apart at towers to 21 ft. apart at midspan may be seen.



SPINNING THE CABLES FROM WIRE ON BALL-BEARING REELS

gorge to a point near the north bridge approach. This railway will be constructed in a crevasse, ascending the canyon wall just east of the hanging bridge, and will be 1,700 ft. in length on a 100 per cent gradient (45 deg. slope)—the purpose being to convey passengers from the hanging bridge at the bottom of the gorge to the suspension bridge at the top. Cars having a seating capacity of 21 persons are to be used. Other amusement features in course of construction or contemplated are an observation pavilion with a powerful telescope located on the south rim of the gorge, a modern hotel and tourist cottage city with playgrounds, a golf course, a swimming pool, and similar recreation facilities for the convenience of visitors.

The writer was responsible for the design and construction of the Royal Gorge bridge. The engineering department of the Denver & Rio Grande Western Railroad, Arthur Ridgway, chief engineer, and O. K. Peck, bridge engineer, checked the design of the bridge and subsequently gave some attention to the supervision of its construction.

Increasing Drainage Canal Capacities in New Orleans

Roughness Coefficient Reduced by New Concrete Lining—Concrete Sheetpiling at Sides Allows Greater Slope

By Alf. F. Theard
Sewerage and Water Board, New Orleans, La.

INCREASING the discharge capacities of the existing drainage canals without necessitating the purchase of additional right-of-way was one of the problems confronting the New Orleans Sewerage and Water Board engineers in the design of the improved drainage facilities for that city. The design adopted calls for a concrete lining to be placed in the old canals for the purpose of reducing the coefficient of roughness, and the use of concrete sheetpiling along the sides to allow a higher water level and an increased slope.

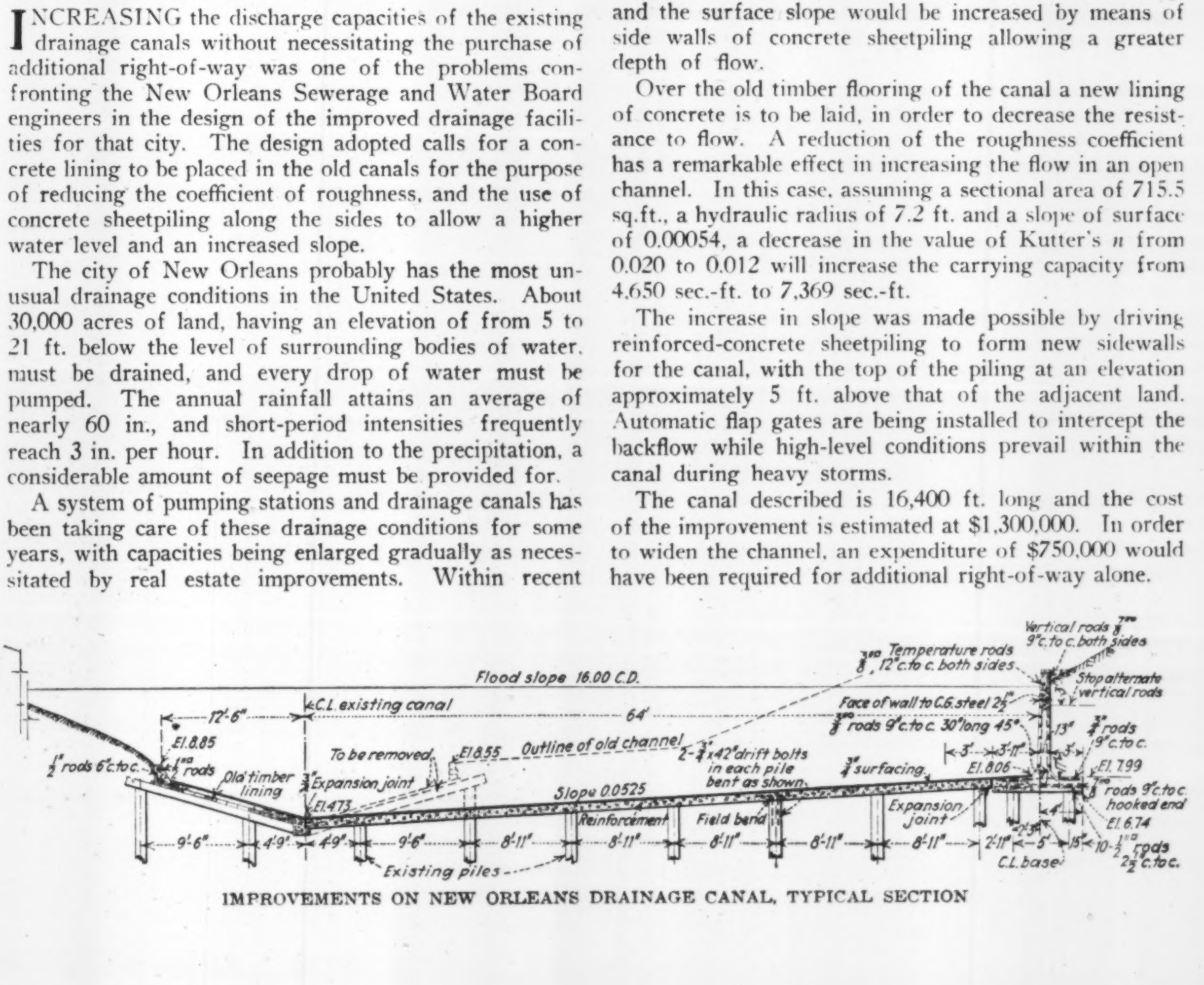
The city of New Orleans probably has the most unusual drainage conditions in the United States. About 30,000 acres of land, having an elevation of from 5 to 21 ft. below the level of surrounding bodies of water, must be drained, and every drop of water must be pumped. The annual rainfall attains an average of nearly 60 in., and short-period intensities frequently reach 3 in. per hour. In addition to the precipitation, a considerable amount of seepage must be provided for.

A system of pumping stations and drainage canals has been taking care of these drainage conditions for some years, with capacities being enlarged gradually as necessitated by real estate improvements. Within recent years, however, a large low-lying area has been developed and paving laid at a rate that gave no consideration to drainage questions. It became necessary to increase the carrying capacity of the open channel connecting the two pumping stations serving this area at a cost which would not exceed the rather low amount allowed. The real estate development had created excessive land values, so that the purchase of additional right-of-way to allow an increase in width was not possible. A plan was adopted whereby the coefficient of roughness of the canal would be reduced by the use of a new concrete lining, and the surface slope would be increased by means of side walls of concrete sheetpiling allowing a greater depth of flow.

Over the old timber flooring of the canal a new lining of concrete is to be laid, in order to decrease the resistance to flow. A reduction of the roughness coefficient has a remarkable effect in increasing the flow in an open channel. In this case, assuming a sectional area of 715.5 sq.ft., a hydraulic radius of 7.2 ft. and a slope of surface of 0.00054, a decrease in the value of Kutter's *n* from 0.020 to 0.012 will increase the carrying capacity from 4,650 sec.-ft. to 7,369 sec.-ft.

The increase in slope was made possible by driving reinforced-concrete sheetpiling to form new sidewalls for the canal, with the top of the piling at an elevation approximately 5 ft. above that of the adjacent land. Automatic flap gates are being installed to intercept the backflow while high-level conditions prevail within the canal during heavy storms.

The canal described is 16,400 ft. long and the cost of the improvement is estimated at $1,300,000. In order to widen the channel, an expenditure of $750,000 would have been required for additional right-of-way alone.


Vertical rods 7/8" 9" c. to c. both sides
3/8" Temperature rods 12" c. to c. both sides
Flood slope 16.00 C.D.
Stop alternate vertical rods
C.L. existing canal
Face of wall to C.G. steel 2 1/2"
12'-6"
64'
3/8" rods 9" c. to c. 30" long 45°
13"
3/4" rods 9" c. to c.
El. 8.85
To be removed
El. 8.55
Outline of old channel
2-3/4" x 42" drift bolts in each pile bent as shown
3/4" surfacing
3'
3'-11"
3'
El. 8.06
El. 7.99
1/2" rods 6" c. to c.
1" rods
Old timber lining
3/4" Expansion joint
El. 4.73
Slope 0.0525
7/8" rods 9" c. to c. hooked end
Reinforcement
Field bend
Expansion joint
4'
2'-3"
El. 6.74
9'-6"
4'-9"
4'-9"
9'-6"
8'-11"
8'-11"
8'-11"
8'-11"
8'-11"
2'-11"
5'
15"
10-1/2" rods 2 1/2" c. to c.
Existing piles
C.L. base

IMPROVEMENTS ON NEW ORLEANS DRAINAGE CANAL, TYPICAL SECTION

Building Code Committee of the U. S. Department of Commerce

What It Is and What It Does

By WILLIAM K. HATT

Purdue University, Lafayette, Ind.; Chairman, Building Code Committee

DR. W. K. HATT

THE BUILDING CODE COMMITTEE of the Department of Commerce is one of the most important technical bodies functioning today. Its importance is measured not alone by the magnitude of the task assigned to it but also by the manner in which it has discharged its duties. As a direct result of its work, hundreds of municipal building codes have been revised, with consequent economy and raised standards in the field of building construction. The committee boasts an eminent roster and has been unusually fortunate in its chairmen. The late Ira H. Woolson was appointed to the office when the committee was organized in 1921 and served faithfully and efficiently until his death in 1927. The present chairman, Dr. William Kendrick Hatt, who has written the accompanying account of the Building Code Committee's work, is also a veteran, having served on the committee continuously since its organization. Dr. Hatt received the first of his many degrees from the University of New Brunswick in 1887 and has since been professor of civil engineering at the University of New Brunswick, instructor in civil engineering at Cornell University, assistant professor in engineering, associate professor of applied mechanics, professor of civil engineering and director of the testing materials laboratory at Purdue University. Professor Hatt has been state engineer of the Indiana State Conservation Department since 1920, chief engineer of the Indiana Flood Commission, and has filled other important offices in the many technical societies of which he is a member. His straightforward account of the Building Code Committee and its work should be read by every engineer. —EDITOR.

THE Building Code Committee of the Department of Commerce was appointed by Secretary Hoover in 1921, when his attention was called to the unnecessary restrictions on building enterprises and to the uneconomical construction caused thereby, both arising from a lack of knowledge of the real requirements in respect to loads on building floors, to stresses on materials, to plumbing fixtures, and from other traditional clauses in building codes. The committee consists of six engineers and architects, and a technical secretary. It is closely associated with the Bureau of Standards, its permanent office being maintained in the division of building and housing of that bureau.

Unlike a great many other committees, the Building Code Committee is not organized along the lines of representation for each industry with a balance between producers and consumers. Rather it is composed of selected professional experts who were judged to be especially fitted for the task in hand. Every material industry affected is consulted before drawing up specific recommendations, but the committee does not labor under the necessity of striking compromises among the divergent views of various industries, as would frequently be the case if it were differently constituted.

The fundamental activity of the committee is directed to the elimination of waste in industry, partly through a process of simplification by reducing an unnecessary variety of requirements to acceptable standards. The process, however, is of a different order from a mere simplification of sizes, because it covers basic matters of engineering design and requires study of scientific data and recourse to new experimentation.

Accomplishments

In its work since 1921 the committee has issued six reports covering respectively the construction of small dwellings, plumbing requirements, minimum live-load requirements for buildings of several occupancies, masonry wall requirements, allowable stresses on materials and a uniform arrangement for building codes. A report on fireproofing requirements is nearly completed. It now becomes possible through a logical and orderly procedure to combine the various recommendations in a single report covering the major items of a building code and giving references to standard authorities where the committee feels that the subject has already been adequately covered. This work is under way and is being prosecuted as fast as can be done with the information at hand. In some cases it may be necessary to wait upon the results of tests, as it has been in the case of previous reports, in order to be on surer ground.

The subcommittee on plumbing issued a revised edition of its plumbing report last year, so that now its recommendations cover not only dwellings but buildings of any height and size. It has recommended a further program of tests at the Bureau of Standards to clear up some points which are still doubtful, and this program will go forward as soon as necessary funds become available.

The reports of the committee merely present its opinion after a study of all of the elements of the situation, and are offered for the use of city and state building code bodies. They have no legal status and do not direct the work of similar committees of the states or cities, but have been widely utilized in the preparation and revision of local codes.

The wide and multiplied contacts of the Department of Commerce with the industries and technical organizations, with engineers, producers and other persons whose opinions, by reason of experience or scientific research, should be consulted as evidence in reaching conclusions in building codes; its organization for digesting and compiling the information ready for the meeting of the committee—these fortunate aids have provided resources which a committee representing a smaller constituency could hardly expect to possess. Furthermore, the committee's intimate relation to the distinguished scientific and engineering staff and elaborate equipment of the Bureau of Standards has served in the development of new information from experimental data in cases where opinions were at variance.

Method of Work

Through a preliminary discussion upon a single section of a building code, the committee reaches a definition of the essential factors underlying, for instance, the requirements for masonry wall construction or working stresses on materials. The committee studies existing codes, gathers together whatever scientific and otherwise reliable information may be available, and, after deliberation in committee meeting, sends out a tentative report to 1,000 or 1,500 representative engineers, architects, building officials, fire chiefs and producers, asking for criticism and suggestions. Hundreds of replies are received and digested, and each member of the committee is supplied with copies of the digests. The tentative report is reviewed in committee in the light of each one of these letters, and a second draft prepared for resubmission to a smaller number of correspondents and contact men. At times the process includes a third report. Finally a formal report is submitted to the Secretary of Commerce for publication. The committee may spend a year upon a single topic of a code.

Ira H. Woolson, Chairman
Building Code Committee 1921-27

As the first chairman of the Building Code Committee of the Department of Commerce, the late Ira H. Woolson had much to do with the sustained and successful progress of the committee during its first six years of existence. Born in Lewiston, N. Y., in 1856, Mr. Woolson was graduated from Columbia University in 1885 with the degree of engineer of mines. He entered the faculty of Columbia University, emerging in 1910 as professor of civil engineering and head of the testing laboratory, which he had directed for twenty years. During the latter years of his university career he established at Columbia one of the pioneer fire-testing stations in the country. In connection with this work, he developed a number of new standard fire-test methods. In 1910 Professor Woolson left the university to be consulting engineer for the National Board of Fire Underwriters. During the war, he served as advisory engineer to the building materials division of the War Industries Board. Mr. Woolson died in 1927.

A building code is understood to be an extension of the police power to provide for public health and safety. Since building codes usually have been prepared by engineers and architects, they have come to include many things which have a very slight connection with public health and safety. Thus they take on the aspect of a manual of construction; they specify small differentials of practice, matters of relative economy; they state principles of mechanics. Some of the requirements at times may be based upon the arguments of representatives for one class of material. This elaboration not only is unnecessary but often operates to hold antiquated codes in force. It is understood that in most cases the law requires the publication of a building code in three issues of the public press, a formidable expense when a code is extended into a treatise on construction.

On the other hand, the necessary code provisions for public health and safety may be composed within a small publication. Matters of good practice in building can then be covered in a supplementary manual which can be printed for the guidance of inspectors, designers and architects. Therefore, one important approach to drafting a building code is to determine and to settle upon the minimum and necessary requirements, and then to print other connected and subsidiary matters as a manual of construction.

The reports of the Building Code Committee of the Department of Commerce are of this nature. For instance, the report on plumbing requirements has 29 pages of requirements and 234 pages of appendix, discussing best methods and practices, and presenting data; the report on masonry walls, 17 pages of requirements and 37 pages of appendix; the report on live load requirements, 4 pages of requirements and 30 pages of appendix, etc.

Facts Revealed by Studies and Some Difficulties

The experience on the committee in formulating these reports has revealed that widespread questionnaires are of not very great directive value. It has also been apparent that the quality of the materials produced in different areas necessarily varies because of the difference in raw materials and methods of manufacture. A third fact that has been learned is that competency of architects and engineers and the experience of inspectors varies widely in communities of different standards of performance of duty; so that the use of high unit stresses on masonry walls, on structural steel or on concrete which might be safe in cities with trained inspectors and where buildings are designed by engineers and architects who compute all the stresses might prove quite unsafe for a community in which the engineer gets his design from some handbook of a manufacturing company, or where the inspector is appointed through political influences. It is difficult to preserve the public safety in one case without penalizing the skill of the designer in the other case.

Again, the practice with respect to stresses and sizes is the result of experience with long-tried materials and forms. The introduction of building materials of greater strength and durability and the scientific knowledge underlying their use demands new code provisions. The thickness of a masonry bearing wall of established type with small openings cannot be directly transferred to the design of a wall of modern type with large windows and other openings.

One difficult situation in the work of any building code committee arises from the rivalry of competing constructions, as, for instance, among brick, concrete, wood and steel construction. Requirements of a building code have to be stated upon the best evidence available. Many of the producing interests at the present time have their organized technical bureaus with competent engineers armed with arguments and evidence apparently supporting their contentions. Almost any decision of the committee affects favorably or adversely these competing interests.

Finally, there are organizations of engineers and other architects which already have adopted and put into wide use building regulations, specifications and practices of various kinds. The committee must necessarily adjust its work to these well-established standards whenever best evidence derived from experience and scientific experiments will justify conformity.

Enough has been said to show that effective work

Edwin H. Brown, Architect

Edwin H. Brown, of the firm of Hewitt & Brown, architects, was a member of the Building Code Committee from its inception. He had been graduated from both Harvard University and Worcester Polytechnic Institute by 1898. He spent several years in the mining fields of Alaska, returning to enter the structural engineering field and sales work in Minneapolis. In 1910 the partnershop with Edwin H. Hewitt was begun. Mr. Brown was secretary of the American Institute of Architects, and was instrumental in the formation of the Architects' Small House Service Bureau in 1919, having served as president of the latter organization up to the time of his death in April of this year.

Joseph R. Worcester, Structural Engineer

Graduated from Harvard College in 1882 at the age of 22, Joseph R. Worcester spent the next twelve years in the employ of the Boston Bridge Works. In 1894 he established an office as consulting engineer in Boston and from 1906 to 1924 continued to practice as a member of the firm of J. R. Worcester & Co. His practice has dealt largely with bridges, subways, elevated railways, foundations and buildings of all kinds. Mr. Worcester has assisted in the compilation of a number of building codes, and is a member of numerous engineering societies. He has been a member of the Building Code Committee of the Department of Commerce since its original appointment.

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of the Building Code Committee is something more than reaching an average of the ideas of the group. Necessarily there must be differences of individual opinion in any group of competent men on a committee, but in so far as possible decisions are based upon best experience of builders and constructors, upon the wealth of scientific data available and upon new experimentation carried out by the Bureau of Standards and devised for the settlement of some undetermined question.

Such was the process in the very difficult report on plumbing requirements, where the Bureau of Standards carried out a very elaborate investigation under the direction of a committee of sanitary engineers and plumbers headed by the late Prof. George C. Whipple, of Harvard University. This report contains a very valuable investigation of the fundamental hydraulics in plumbing and drainage fixtures, showing that many existing code requirements add unnecessarily to the cost of building and require an unnecessary volume of manufactured product. It is hoped that further experiments on large plumbing installations can be undertaken.

Identified with buildings and building code development in a prominent way during the past 35 years, Rudolph P. Miller, now a consulting engineer in New York, is probably the dean of building code experts. By 1888 Mr. Miller had acquired degrees from both the College of the City of New York and Columbia University. In 1895 he entered the service of the New York City department of buildings, resigning in 1906 to enter private practice. In 1910 he returned to city service as superintendent of buildings for the Borough of Manhattan. During 1914-15 and part of 1916 he had charge of the revision of the New York building code. In July, 1916, Mr. Miller was appointed chairman of the board of standards and appeals, a newly created body for rendering interpretations of the building laws when disputes arose, and for formulating rules to place the building code in effect in a uniform manner in all boroughs of the city.

Rudolph P. Miller

Serving for a short period with the U. S. Housing Corp., Mr. Miller returned to private practice after the war, and in 1920 was appointed superintendent of buildings for the Borough of Manhattan for the second time, serving two years in that capacity. At present he is engaged in private practice, his work being chiefly in the preparation of building codes and zoning ordinances for various municipalities, serving as consultant in the introduction of new materials and forms of construction, investigating building failures, making reports on existing buildings, etc. Mr. Miller has been a member of the Department of Commerce Building Code Committee since its inception.

Another problem arose when the committee found that the office buildings in neighboring localities were designed for floor loads of from 50 to 150 lb. per square foot. Either the lower limit is unsafe or the upper limit has added an unnecessary cost to an office building, which is really a tool of industry. The extra cost of the material to support the larger loads must appear in the price of the product whose manufacture or use or the services in connection therewith have been the occasion of the erection of the building. The committee gathered together data by actually weighing the contents of buildings of various occupancies to find out what actual loads are really to be expected. For instance, it was found that in the Equitable Building in New York the average floor load was only 11 lb. per square foot and even in the selected heavy occupancies only 42 lb. per square foot. The heaviest loading of filing cases in a building occupied by an insurance company was 50 lb. per square foot. For such occupancies, on the basis of this information, the committee set up uniform live-load requirements.

These are some of the difficulties that confront any

Albert Kahn, Industrial Architect

Born in Germany in 1869, Albert Kahn came to this country at the age of twelve years. Starting as an office boy with Mason & Rice, he rose to the position of head draftsman at the age of 25. Subsequently he became a member of the newly formed firm of Nettleton, Kahn & Trowbridge, which became "Albert Kahn" after Mr. Trowbridge's acceptance of the deanship of the school of architecture at Cornell and Mr. Nettleton's death. Mr. Kahn has specialized in industrial architecture, doing work for Ford, Packard, Hudson, Chevrolet, Dodge, Chrysler, and others. He was the architect for the General Motors Building and the new Fisher Building in Detroit, as well as for many other important commercial, bank and club buildings in other cities. He has recently been engaged by the Soviet Republic of Russia as a consultant. Mr. Kahn has been a member of the Building Code Committee since 1923.

J. A. Newlin, Expert on Timber Mechanics

In all things pertaining to timber stresses, grading rules and the efficient use of timber in engineering structures, J. A. Newlin, head of the section of timber mechanics of the Forest Products Laboratory, Madison, Wis., has a part. His foundation was laid during the five years between completing high school and entering the university, when he worked with his father in carpentry work. He was graduated from Purdue University in 1900, spent four years in railway maintenance-of-way work, and in 1904 returned to Purdue as engineer on timber tests in the U. S. Forest Service. When in 1910 the Forest Service timber-testing work was moved from Purdue and consolidated with other research at Madison, Mr. Newlin was placed in charge of the section of timber mechanics. He has been a member of the Building Code Committee of the Department of Commerce throughout its existence.

building code committee. We should not run away from them, but seek an answer in accordance with best practice suitable to the locality and based on facts rather than tradition.

This discussion might be extended to cover other phases, of fireproofing requirements in various zones of the city, of exits, sanitary features and other matters not strictly within the realm of construction engineering.

Evidence of the usefulness of the committee's work is to be found in the extent to which its recommendations find their way into local legislation. A canvass is made each year of cities and towns having more than 5,000 population, and contact is made with those municipalities found to be revising their codes. Last year's canvass reported upon the status of building and plumbing codes in 858 municipalities and shows that 281 were revising their building codes and 191 their plumbing codes. A total of 207 municipalities report that they have used the recommendations of the Building Code Committee in preparation or revision of their local codes, and 102 municipalities report the use of the recommendations of the subcommittee on plumbing.

Stormwater Inlet Grating, Borough of Manhattan, New York

Type Designed After Long Study Satisfactory in Four Years' Use—Medium Cast Steel With Three Sides and Bottom Machined

By O. Hufeland

Assistant Engineer, Office of Borough President of Manhattan, New York City

IN THE Borough of Manhattan it is the practice in the newer constructions to keep the street crossings dry for pedestrians by intercepting water flowing in the street gutters in receiving basins or inlets placed close to the uphill side of the crossing. Success depends, first, on the shape of the pavement, which must concentrate the water around the basin; second, and more difficult, upon the grating over the mouth of the basin which must take all the water brought to it. To design a grating to meet this requirement would seem a simple problem, but our experience has shown that much study and many trials were necessary to find one that would offer the least resistance to the flow and at the same time be strong enough to support the heavy vehicles that cross it. Twenty-ton trucks are in common use here, hence the grating would have to carry rather more than 13,000 lb. if one of the wheels passed over it.

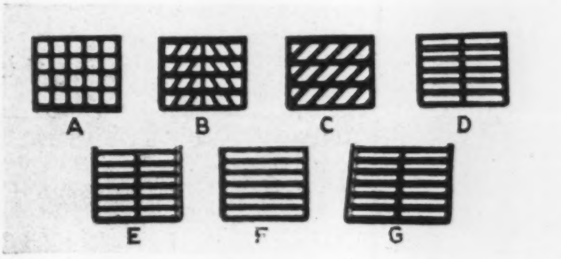
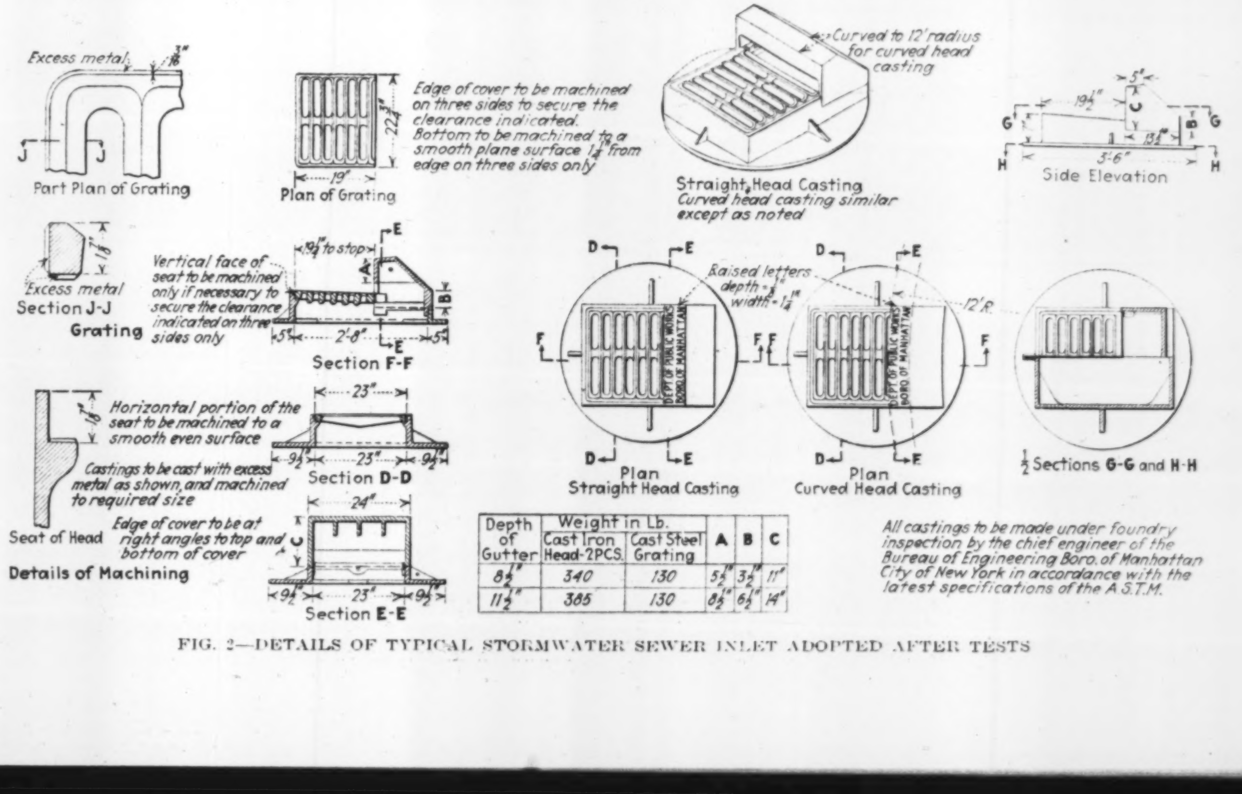


FIG. 1—TYPES OF STORM SEWER INLET GRATINGS TESTED—TYPE G WAS ADOPTED. SEE ALSO FIG. 2

A number of different gratings have been used here, but all of them either caused a great surge to form, which spread the water over the street crossing, were easily obstructed on the surface by street debris, were dangerous to pedestrians wearing the modern pointed-shoe heels or else permitted the passage of objects that eventually clogged the culverts leading to the sewer. Some years ago the writer, at the suggestion of C. M. Pinckney, chief engineer of the borough president's office, and his principal assistant, H. W. Levy, made a series of tests that yielded interesting results.


Excess metal
3/16"
J
J
Part Plan of Grating
22¾"
19"
Plan of Grating
Edge of cover to be machined on three sides to secure the clearance indicated. Bottom to be machined to a smooth plane surface 1¼" from edge on three sides only
Curved to 12' radius for curved head casting
Straight Head Casting
Curved head casting similar except as noted
5"
19½"
13½"
3'-6"
G
G
H
H
B
C
Side Elevation
1⅛"
Excess metal
Section J-J
Grating
Vertical face of seat to be machined only if necessary to secure the clearance indicated on three sides only
19½" to stop
A
B
E
E
5"
2'-8"
5"
Section F-F
D
E
D
E
F
F
F
F
Raised letters depth-3/16" width-1½"
12'R
DEPT OF PUBLIC WORKS BORO OF MANHATTAN
Plan
Straight Head Casting
Plan
Curved Head Casting
½ Sections G-G and H-H
1⅛"
Horizontal portion of the seat to be machined to a smooth even surface
Castings to be cast with excess metal as shown, and machined to required size
Seat of Head
Details of Machining
23"
9½"
23"
9½"
Section D-D
Edge of cover to be at right angles to top and bottom of cover
24"
C
9½"
23"
9½"
Section E-E

Depth of Gutter	Weight in Lb.		A	B	C
	Cast Iron Head-2PCS.	Cast Steel Grating			
8½"	340	130	5½"	3½"	11"
11½"	385	130	8½"	6½"	14"

All castings to be made under foundry inspection by the chief engineer of the Bureau of Engineering Boro. of Manhattan City of New York in accordance with the latest specifications of the A.S.T.M.

FIG. 2—DETAILS OF TYPICAL STORMWATER SEWER INLET ADOPTED AFTER TESTS

First, a number of full-sized wooden models of gratings were made that fitted into the existing iron basin heads. With a wagon carrying a 3-in. meter and sufficiently large-sized hose to control the flow of the water from the street hydrants, a measured stream was turned into the gutters and the various grating models were inserted in the basin heads, one after another without changing the flow. The quantity of water being known and its velocity in the gutters measured by floats, quite definite results were obtained for all the gratings.

Such tests were made at twelve or fifteen points under widely varying conditions. The amounts of water used ranged from 30 to 60 cu.ft. per minute, generally as much as the gutter would hold without overflowing. The first trial was made into a basin from which the grating had been removed and then, one after another, the various models were put in place without changing the flow. This method showed to what degree each model obstructed the flow into the basin and determined its efficiency. The photographs were all taken at the southeast corner of 80th St. and West End Ave. during one of the tests. The conditions existing there presented a little more than the average difficulty in intercepting the flow, the grade of the street being about 3 per cent. The flow of water at the time the pictures were taken was about 60 cu.ft. per minute and the velocity in the gutter about 6 ft. per second. The pavement around the basin did not have quite the proper shape, which accounts for the spread of the water shown, even when the basin mouth was unobstructed by any grating.

The first three models tested were quickly discarded for reasons easily understood from the photographs, and the type represented by the four others was found superior. In the test it became apparent that even slight changes had an appreciable effect on the water as it reached the grating, and a careful examination will show the changes made, each one adding a little to its efficiency. That marked *G* was finally adopted and is now in use here. With a proper depression in the pavement to concentrate the flow, it comprises an excellent sewer grating.

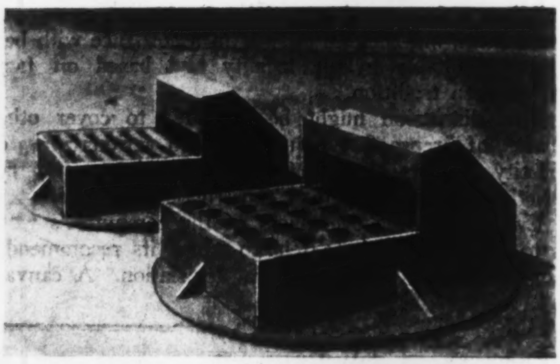


FIG. 4—OLD AND NEW TYPE OF STORMWATER SEWER INLET
Old below; new above. Made of mild cast steel.

The grating adopted here is made of medium cast steel, the strength of this metal permitting a much lighter casting and consequently more openings for the passage of the water. Three sides and the bottom of the grating are machined with a similarly prepared surface to rest on in the head. This prevents "rocking," reduces noise from passing vehicles and adds to the life of the whole. This grating has given perfect satisfaction during the four years that it has been in use. Notwithstanding the heavy traffic and its use under many unfavorable conditions, not one of them has worn out or been broken. Its weight is about 215 lb. and it costs about 7c. a pound. Perhaps the best recommendation for the grating is the enthusiasm of the maintenance gangs.

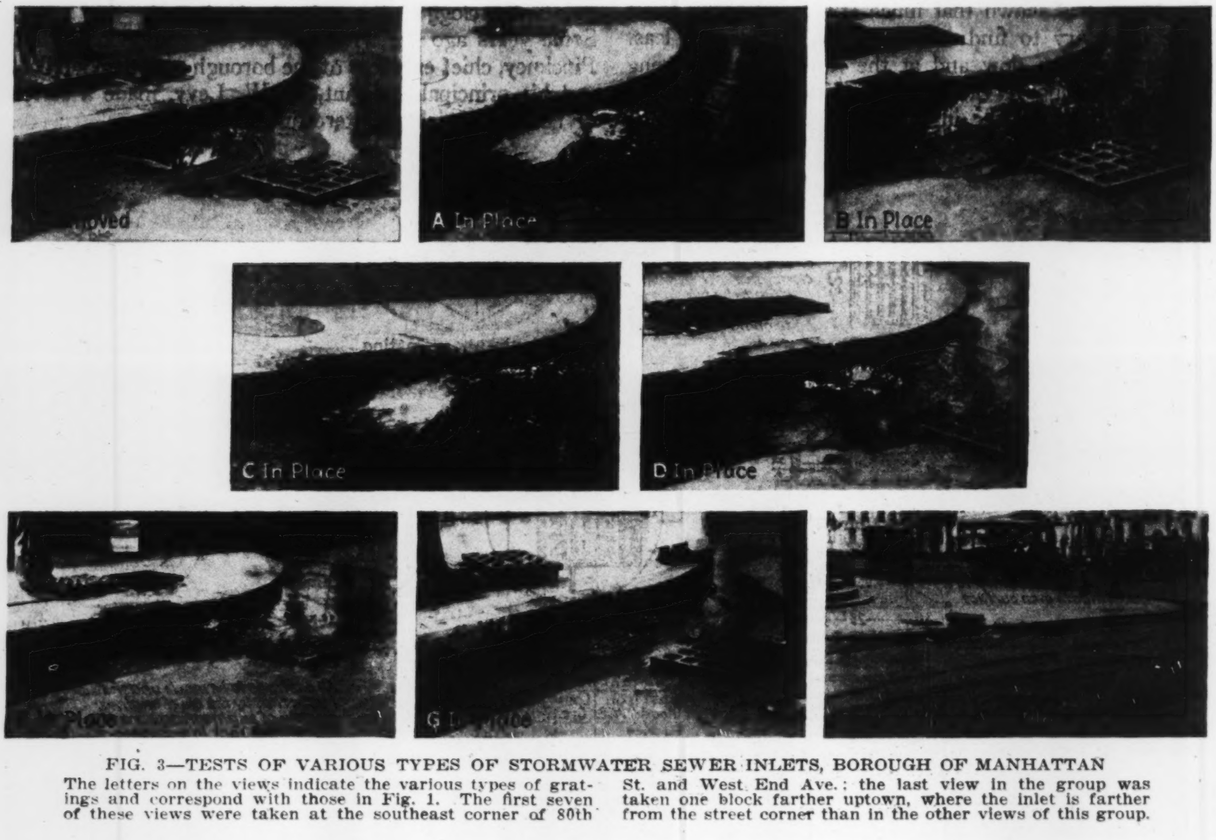


FIG. 3—TESTS OF VARIOUS TYPES OF STORMWATER SEWER INLETS, BOROUGH OF MANHATTAN
The letters on the views indicate the various types of gratings and correspond with those in Fig. 1. The first seven of these views were taken at the southeast corner of 80th St. and West End Ave.; the last view in the group was taken one block farther uptown, where the inlet is farther from the street corner than in the other views of this group.

Investigation of Crushing Loads on Cast-Iron Pipe Under Rockfill

Action of Rockfill Conforms to Marston's Theory of External Loads Under Earthfills—Great Importance of Proper Bedding of Pipe, Foundation Settlement and Other Construction Precautions Demonstrated

By M. G. Spangler
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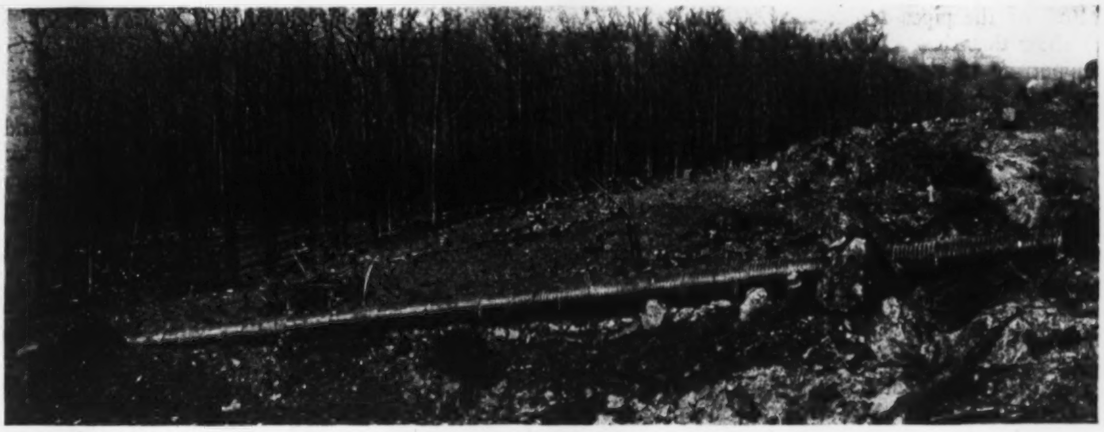

FIG. 1—A CULVERT READY FOR COVERING
Culvert No. 2, April 30, 1929, just after completion; character of subgrade and the bedding of the pipe well indicated.

THE THEORY of external loads on conduits under embankments, developed and published* by Director Anson Marston, of the Iowa Engineering Experiment Station, has been verified repeatedly by experimental and field observations of loads on culverts under fine granular fills, such as loam, clay and gravel. In the spring of 1929 the Iowa State Highway Commission authorized the construction of three cast-iron pipe culverts under rockfills 15 ft., 23 ft. and 20 ft. high, respectively, over the top of the pipes at the centerline of the roadway. An opportunity was thus presented to check the load theory with the action of rock embankments, and enough evidence has been gained in the investigation to state conclusively that the theory is applicable under these conditions.

In particular it has been demonstrated that seemingly small settlements of culvert foundations have comparatively great effect in reducing the load on the culvert, and it seems certain that if Marston's theory had been available and its principles applied when the bedding of these culverts was designed, the load on the culverts could have been held down to an amount which the pipes could have carried without cracking. As they were actually installed, two of the culverts have failed by cracking, and the failure of one of these has progressed to the point of total collapse of about half of the pipe sections.

These culverts (Fig. 1) were constructed of 36-in. spirally corrugated cast-iron pipe laid in sections about 3 ft. long. Three edge-bearing laboratory tests on five specimens of the pipes showed an average supporting strength of 6,000 lb. per linear foot.

The embankments were constructed of limestone rock taken from adjacent solid rock cuts, and the material varied in size from that of chats up to individual pieces 3 or 4 ft. in dimension. This material was carried up to within about 2 ft. of the finished grade, the rest of the fill being a yellow clay soil. The embankments weighed about 140 lb. per cubic foot according to limited weighings of typical samples, and from observation of the angle of repose of the fills the coefficient of internal friction seemed to be approximately 0.7.

The pipes were bedded on a shallow earth cushion of varying thickness over the natural bedrock as shown in Fig. 7. Culvert No. 1 differed from the two others in that it was laid in a shallow ravine right at the base of a steep slope, and this location reduced the load on it considerably, as will be brought out later. In all three cases, hand stone was placed around the pipes to protect them from injury due to falling rocks when the material was dumped.

Observations and Measurements

Measurements of the vertical and horizontal diameter changes and of settlements of the crown and invert of the pipes were made on culverts Nos. 1 and 2 as the fill was constructed. These data are shown graphically in Figs. 3, 4 and 5. As indicated on the profile of the invert of culvert No. 2, there is a distinct upward bulge of the flow line in the vicinity of the sections in group *B*. These sections are cracked and deformed much more than the adjacent units, and it is quite evident that they were unable to settle with the adjacent fill material to the same extent as the other sections, due to a thinner layer of earth cushion underneath, and they were, therefore, subjected to breaking loads much earlier. They cracked when the embankment was about 16 ft. high over their top.

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*Bulletins Nos. 31, 36, 47, 57, Second Progress Report, 76, 79, 80 and 93, Iowa Engineering Experimental Station. Theory summarized in a paper read before the Advisory Council on Highway Research, Washington, D. C., Dec 12, 1929. Reprinted as Bull. 96, Iowa Engineering Experiment Station.

Culvert No. 3 was constructed and the fill placed over it during February, 1929, before this study was started, so that its diameter changes and settlements are not available. An inspection of this culvert about six months after completion showed it to be in very bad condition, a number of pipes being completely collapsed and others badly deformed as shown in Figs. 3–5.

Probable Loads on These Culverts

Extensive research being conducted by the author to establish the ratio of field supporting strength to laboratory strength of rigid-culvert pipes on ordinary projection bedding (that is, when the bedding is shaped to fit the bottom of the pipes for at least 50 per cent of its width) show that these cast-iron pipes have a probable field supporting strength of 2 to 2.3 times their laboratory strength, or from 12,000 to 14,000 lb. per linear foot. A study of the diameter changes of culvert No. 2 establishes the fact that two groups of pipes, *A* and *C*, are supporting this load under heights of fill of 19.7 ft. and 25.1 ft., respectively. Since culvert No. 3 failed so completely, the load on it must have exceeded this amount at some time previous to the completion of the embankment.

Sections in Group *B* of culvert No. 2 cracked under a height of fill of about 16 ft., but since they had approached contact with the solid rock substrata, the vertical reaction on the bottom of the pipe undoubtedly tended to concentrate at the center of the pipe, and the supporting strength of the pipes was thereby reduced. About 10,500 to 12,000 lb. per linear foot would seem to be a fair estimate of this reduced supporting strength.

Culvert No. 1 has apparently been subjected to much less load than the other two. Measurements show that sections 15 to 20 inclusive, under the highest portion of the embankment, have deflected 0.2 in. or about one-third their ultimate deflection. Some current load-measuring experiments being conducted by the author on 42-in. cast-iron pipe show the load-deflection diagram to be a curve, the deflection increasing more rapidly as the load increases. Roughly, it requires about half the ultimate load to produce one-third the ultimate deflection. From this it is safe to say that these sections are carrying about 6,000 to 7,000 lb. per linear foot under a height of fill of 17.6 ft.

Brief Statement of Marston's Conduit Load Theory

The vertical load on a conduit due to an embankment is the resultant of two vertical forces: first, the weight of the prism of material directly over the conduit, and second, a friction increment acting upon the vertical boundary planes of such prisms as are tangent to the sides of the conduit. This friction increment is caused by differential settlement of the material over the conduit in relation to the material on either side and, in the case of the incomplete projection condition illustrated in Fig. 8, acts downward and increases the load to an amount greater than the weight of the material over the conduit.

Since the modulus of compression of the fill material is the same throughout its mass, this added pressure causes greater settlement per unit height of fill within the prism over the conduit than occurs in the columns of material adjacent to it, so that at a certain height fill the settlement of the material over the conduit and that alongside becomes equal. This height is known as the height of equal settlement. It occurs when the lesser pressure on the material adjacent to the conduit times its greater height equals the greater pressure on the material over the conduit times its lesser height. Above this plane no friction increment exists, because there is no relative movement or tendency for movement between the material over the conduit and that adjacent to it.

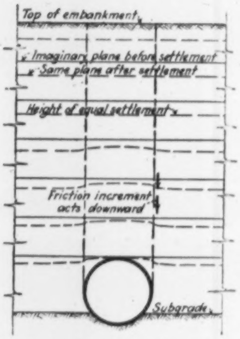

Top of embankment
Imaginary plane before settlement
Same plane after settlement
Height of equal settlement
Friction increment acts downward
Subgrade

FIG. 2—DIAGRAM ILLUSTRATING INCOMPLETE PROJECTION CONDITION

In the incomplete ditch condition which may prevail when the conduit is very flexible or is bedded on very yielding foundation material, the differential settlement of the material over the conduit and that adjacent to it is reversed in direction and the friction increment acts upward. The resultant load is thereby reduced to an amount less than the weight of the prism of material over the conduit.

Mathematical Formulas for Calculating Vertical External Loads on Projecting Conduits Due to Fill Materials

Notation

Let B_c = greatest horizontal breadth of conduit, feet.
C_c = load calculation coefficient for projecting conduits.
H = height of embankment above top of conduit, feet.
H_e = height of equal settlement, feet.
p = the projecting ratio equals the ratio of the height of the top of the conduit above the embankment subgrade level to B_c. The conduit projection equals pB_c.
d_c = the increment of vertical deflection of the conduit, feet.
s_f = the increment of settlement of the conduit foundation, feet.
s_g = the increment of settlement of the embankment subgrade, feet.
s_m = the increment of settlement of materials adjacent to the conduit between the levels of the conduit top and the embankment subgrade, feet.

NOTE: d_c, s_f, s_g and s_m are increments due to the addition at or above H_e of any incremental, uniform layer of fill material.

r_{sd} = the settlement-deflection ratio = $\dfrac{(s_m + s_g) - (d_c + s_f)}{s_m}$

NOTE: A negative value of r_{sd} indicates the incomplete-ditch condition prevails. A positive value indicates the incomplete-projection condition.

W_c = the vertical external load on a conduit due to fill materials, pound per linear feet.
w = the unit weight of fill materials, pound per cubic foot.
K = the ratio of active horizontal pressure at any point in a fill to the vertical pressure which causes the active horizontal pressure. (Rankine's formula recommended.)
μ = the coefficient of internal friction of the fill materials.
ϵ = the base of natural logs.

Then:

$$W_c = C_c\, w\, B_c^2 \qquad (4)$$

For the complete ditch and projection conditions:

$$C_c = \frac{\epsilon^{\pm 2k\mu \frac{H}{B_c}} - 1}{\pm 2k\mu} \qquad (5)$$

For the incomplete ditch and projection conditions:

$$C_c = \frac{\epsilon^{\pm 2k\mu \frac{H_e}{B_c}} - 1}{\pm 2k\mu} + \left(\frac{H}{B_c} - \frac{H_e}{B_c}\right) \epsilon^{\pm 2k\mu \frac{H_e}{B_c}} \qquad (6)$$

NOTE: In formulas (5) and (6), use the — sign for the ditch conditions and the + sign for the projection conditions.

For calculating H_e in equation (6):

$$\epsilon^{\pm 2k\mu \frac{H_e}{B_c}} \pm 2k\mu \frac{H_e}{B_c} = \pm 2k\mu r_{sd} p + 1 \qquad (7)$$

NOTE: In equation (7),
use the —, + and — signs for the ditch condition.
use the +, — and + signs for the projection condition.

A computation diagram for obtaining values of C_c to substitute in formula (4) is shown in Fig. 8.

The product of the settlement-deflection ratio and the projection ratio ($r_{sd}p$), while perfectly rational in the theory and formulas, is not capable of accurate determination in the case of an actual culvert. It should therefore be considered as a semi-empiric quantity the value of which must be established for given conditions by observation of the loads on experimental structures, and actual field installations.

These formulas give the maximum probable load to which a conduit may be subjected. Because of the fact that earthfills are only partly elastic, and other indeterminate factors, some conduits may escape the full amount of this load for long periods of time, although it is not safe to design culverts for loads of lesser magnitude.

There are a number of observed phenomena in connection with these culverts, which are apparently quite contradictory, but which are readily explained by Marston's theory.

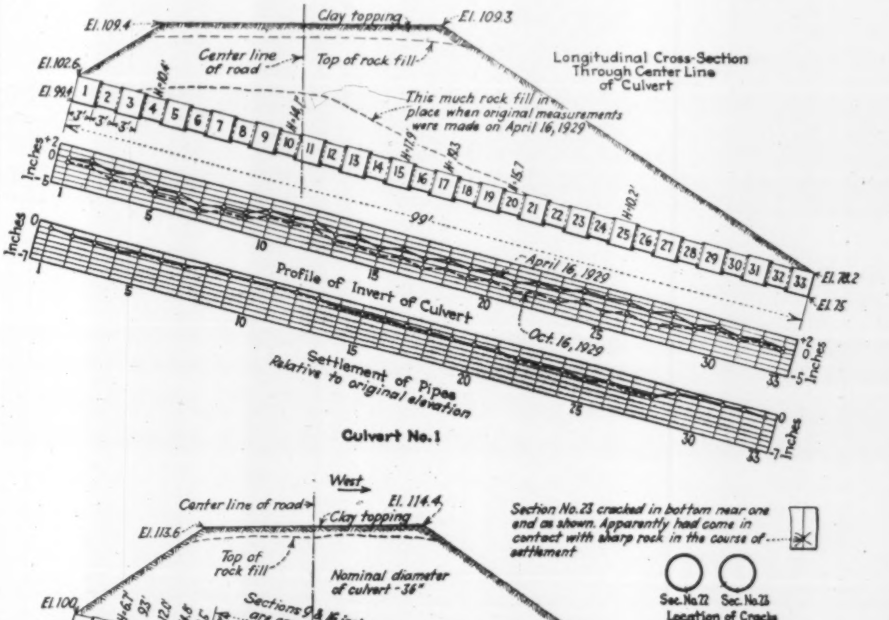
1. Culvert No. 1, under a maximum fill of 19.3 ft. is in very good condition; the average maximum deflection of the six sections under the highest portion of the fill being only about one-third the ultimate deflection which the pipes will stand before cracking, while culvert No. 3, under only a slightly higher fill, has failed completely and shows evidence of having cracked under a relatively very low height of fill.

2. In culvert No. 2, three groups of pipes have been loaded to the cracking point by widely divergent heights of fill. Group *B* cracked at 16 ft.; while groups *A* and *C* cracked or reached their nominal ultimate deflection under heights of fill of 19.7 ft. and 25.1 ft., respectively.

In culvert No. 1, the relatively light loads are explained by the fact that the pipes were laid at the base of a very steep slope, as shown in Fig. 7, which produced the ditch condition on one side of the culvert, while the projection condition prevailed on the other. The friction increment of the load was therefore made up of two forces one acting upward on one side and the other acting downward on the opposite side. We may evaluate these forces roughly by calculating the load on the conduit as if it were laid in a ditch of an assumed width of 5 ft., which gives a load of about 4,600 lb. per linear foot. Then calculating the load as if the projection condition prevailed, with values of $r_{sd}p$ from 0.0 to +0.3 gives values from 8,000 to 12,000 lb. per linear foot. The average of these values gives loads varying from 6,300 to 8,300 lb. per linear foot, which checks quite well with the estimated load of 6,000 to 7,000 lb. per linear foot.

Result of Unequal Settlement

In culvert No. 2, an inspection of the profile of the flow line of the conduit reveals the reason for the wide spread in the height of fill at which the pipes cracked. Group *B* was not able to settle into its foundation


El. 109.4
Clay topping
El. 109.3
Center line of road
Top of rock fill
Longitudinal Cross-Section Through Center Line of Culvert
El. 102.6
El. 99.4
This much rock fill in place when original measurements were made on April 16, 1929
99'
April 16, 1929
Oct. 16, 1929
Profile of Invert of Culvert
Settlement of Pipes Relative to original elevation
Inches
El. 78.2
El. 75
Culvert No. 1
West
Center line of road
El. 114.4
Clay topping
El. 113.6
Top of rock fill
Nominal diameter of culvert - 36"
Section No. 23 cracked in bottom near one end as shown. Apparently had come in contact with sharp rock in the course of settlement
Sec. No. 22
Sec. No. 23
Location of Cracks
El. 100
El. 96.8
Sections 9 & 16 incl. are cracked
Sections 22 & 23 are cracked
Group A
Group B
Group C
117'
April 30, 1929 no fill
El. 73.1
El. 69.9
Distance between lines represents vertical deflection of pipes
Profile of Invert of Culvert
Oct. 16, 1929 and Nov. 13
Settlement of invert
Settlement of Pipes Relative to original elevation
Settlement of top of pipe
Sec. No. 9
No. 10
No. 11
No. 12
Sec. No. 13
No. 14
No. 15
No. 16
Location of Cracks Nov. 13, 1929
Culvert No. 2
El. 116
El. 117.6
Clay topping
El. 116.2
El. 105.9
Center line of road
Top of rock fill
Deformed Sections
Collapsed Sections
Typical Failures
El. 100
El. 96.4
Cracked
Badly deformed
Apparently completely collapsed
Sound
138'
Deformed
Sound
El. 93.2
El. 90
Culvert No. 3

FIGS. 3-5—GRAPHS OF DEFLECTIONS, DIAMETER CHANGES AND BREAKS IN THREE CULVERTS nearly as much as groups *A* and *C*. Therefore, the quantity s_f was not so great, making the value of $r_{sd}p$ materially greater in this group, which increased the load considerably for equivalent heights of fill. From the estimated loads on these groups and the corresponding heights of fill, the empiric values of $r_{sd}p$ at the time of cracking, are calculated to be: Group *A*, +0.13 to +0.36; Group *B*, +0.24 to +0.51; Group *C*, 0.00 to +0.06.

Culvert No. 3 was constructed and the fill placed during February, 1929, which in this vicinity was an unusually cold month. An examination of the Weather Bureau records for this month at Dubuque, Iowa, about 40 miles distant, shows the departure from the mean temperature to have been —8.6 deg. It is quite certain therefore than the earth cushion on which these pipes were placed was either in a frozen state when placed or that it froze soon after. In either case the bedding was very unyielding, while the nature of the rockfill was such that it would not freeze solid and would probably settle as much as if it had been placed in warm weather. This combination of circumstances produced very high positive values of $r_{sd}p$, and consequently very high loads.

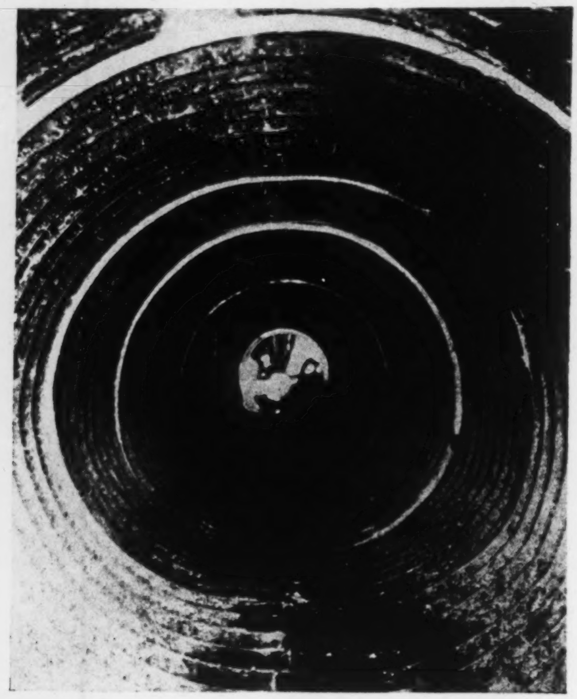


FIG. 6—INTERIOR VIEW OF CULVERT NO. 2 SHOWING BREAKS

If we assume values of $r_{sd}p$ of + 1.5 to + 2.0, which seem not at all unlikely, and an ultimate load of 12,000 to 14,000 lb. per linear foot, these pipes must have cracked under a height of fill of from 12 to 15 ft.

The fact that some of the pipes near the ends of this culvert are cracked under very low heights of fill is not explained by a direct application of the theory, since even the very severe complete projection condition, formula (5), does not give sufficiently heavy loads to crack them under fills less than about 10 ft. However, by visualizing the action of the fill after the first pipe section failed completely, this phenomenon is easily explained by an extension of the principles of the theory.

It appears from this investigation that culverts Nos. 2 and 3 might have been rendered safe against injurious cracking if the very great influence of foundation settlement on reduction of loads on conduits had been known and realized and adequate provision made to insure such settlements to have taken place freely and completely while the embankments were being placed. In the case of culvert No. 2, this could have been accomplished by increasing the depth of the earth cushion under the pipes. In the case of culvert No. 3 it would have been necessary to keep the earth cushion from freezing during the construction of the embankment.

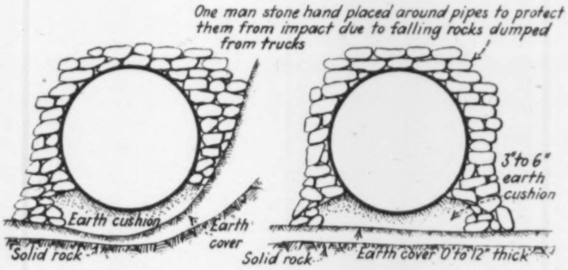
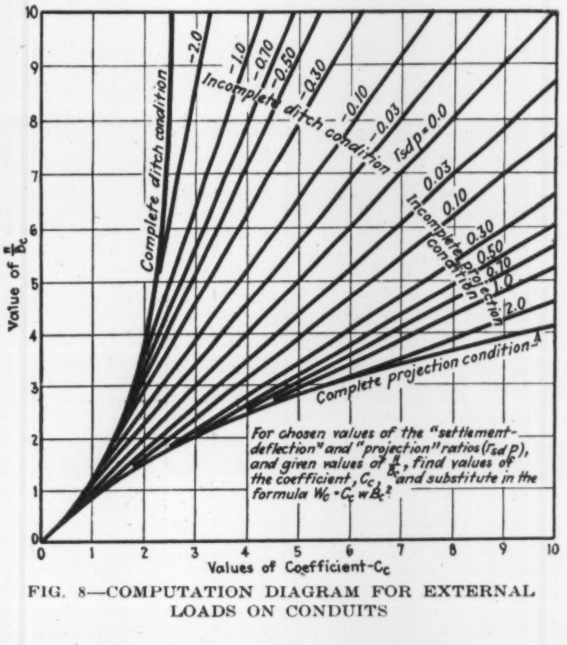

One man stone hand placed around pipes to protect them from impact due to falling rocks dumped from trucks
3" to 6" earth cushion
Earth cushion
Earth cover
Solid rock
Solid rock
Earth cover 0 to 12" thick

FIG. 7—APPROXIMATE BEDDING CONDITION OF CULVERT NOS. 1, 2 AND 3

In any design where settlement of the foundation is provided for it would be well to camber the flow line of the culvert in amounts proportional to the height of fill over the pipes in order to secure a final grade line somewhere near a straight line.

Load Reduction by Trenching

Another method which might have been employed to reduce the loads on these culverts would have been to excavate a trench about as deep and slightly wider than the diameter of the pipes and to have constructed the culvert in this trench. This would have reduced the value of the projection ratio *p*, and thus have accomplished the same result as the first method mentioned above. It would have been an expensive method in this particular case because of the rock substrata, but in structures where the foundations are in earth and the streambed elevations will permit, it is a very effective means of reducing loads.



For chosen values of the "settlement-deflection" and "projection" ratios ($r_{sd}p$), and given values of $\frac{H}{B_c}$, find values of the coefficient, C_c, and substitute in the formula $W_c = C_c w B_c^2$

FIG. 8—COMPUTATION DIAGRAM FOR EXTERNAL LOADS ON CONDUITS

Novel Combination Steel and Wood Arch Roof

St. Louis Exhibition Building 278 Ft. Wide Includes Steel Cantilever Trusses and Framing at Sides to Carry Central Timber Portion of 155-Ft. Span

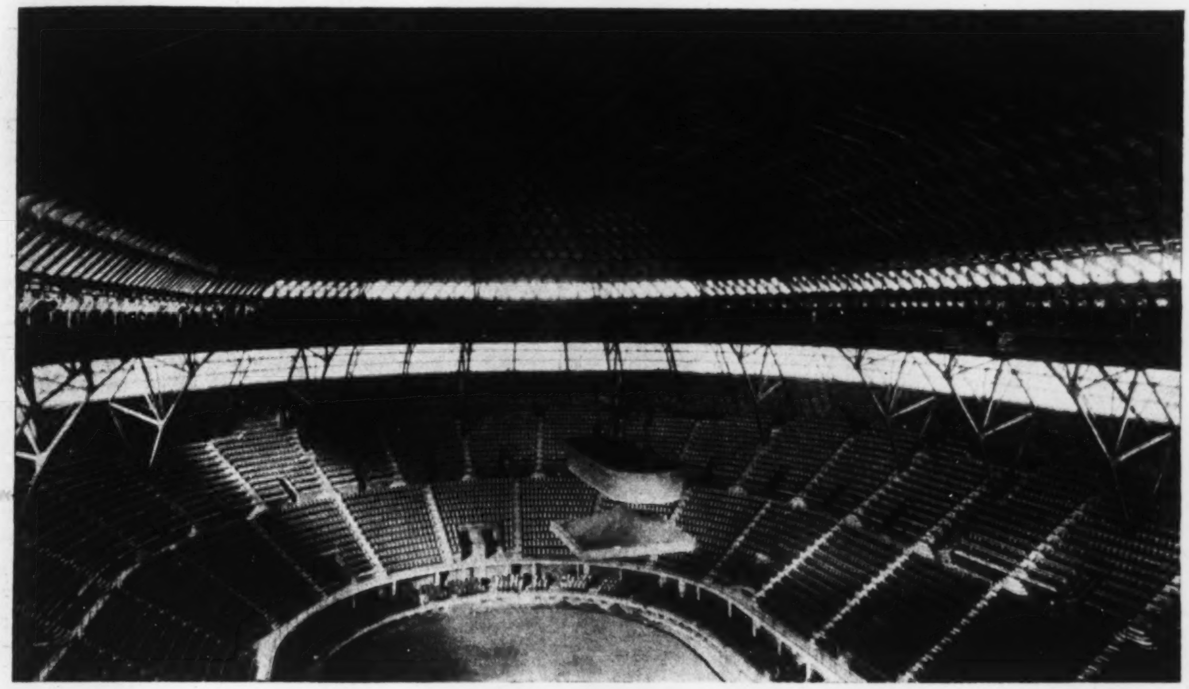


FIG. 1—INTERIOR OF THE ARENA, ST. LOUIS, MO.
Width 278 ft. Steel cantilever trusses carry timber arch roof of 155-ft. span

SOMETHING new in long-span roof design is a combination of steel cantilever trusses forming the side portions and supporting a timber arch which spans the central portion of an arena or stadium which is the principal structure on the new 58-acre grounds of the National Exhibition Co., at St. Louis, Mo. The building, 278 ft. wide over the walls, has an arched roof consisting of two rows of tall steel cantilever trusses, the heads of which carry a central arch of timber "lamella" construction having a span of 155 ft. and a rise of 35 ft., the crown being 135 ft. above the floor. The building is 476 ft. long over its curved ends and provides seating accommodation for 21,000 persons. An interior view of this large and lofty structure is shown in Fig. 1, while Fig. 2 shows the steel erection and Fig. 3 is a typical cross-section. Wood lamella roof construction is used also on two smaller exhibition buildings.

Steel Cantilever Framing—An oval show ring or arena 108x268 ft., occupying the center of the building, is surrounded by two rows of boxes, beyond which are terraced seats extending back to the walls. In order to insure an unobstructed view of the arena from every seat it was necessary to provide a roof without intermediate supports. At the same time financial conditions necessitated economical construction. After consideration of different plans, a special design was evolved consisting of steel cantilever trusses projecting over the seat space and supporting a central portion of lightweight timber construction.

These steel trusses do not spring from the ground level, but are supported at the level of the top row of seats, as shown in Figs. 3 and 4, the base of each truss being a heavy inclined box girder carrying the terraced seats. Below this girder and forming a continuation of it is an inclined girder composed of a pair of 15-in. channels with 22x⅜-in. cover plates at top and bottom. Its lower end is attached to the apex of an A-frame built up of 12-in. H-beams, this frame in turn being mounted on a pair of 30-in. plate girders anchored to a massive block of concrete. Thus uplift at the heel of the cantilever is transmitted through the inclined girder and resisted by the anchorages.

There are five trusses along each side and five in each curved end, the latter being arranged radially, as shown in Fig. 7. All of them are 20 ft. 6 in. wide at the base and 53 ft. 6 in. high, with the top 100 ft. above the arena floor and having an overhang or cantilever projection of 35 ft. They are spaced 40 ft. apart along the sides. In the curved ends there are two trussed steel ribs between each pair of cantilever trusses, to support the purlins, as shown in Figs. 6 and 7. All truss members are 12-in. H-beams. Five lines of longitudinal trusses connect the cantilevers, as indicated in Fig. 3. Details of the truss design are given in Fig. 4.

Reinforced-concrete construction is used for the basement and supports the steel superstructure carrying the concrete mezzanine floor and the terraced seats, which consist of 19½-in. steel risers and 30-in. concrete treads poured in place. Steel erection was handled by a steel stiff-leg derrick with a 120-ft. boom, the mast being an

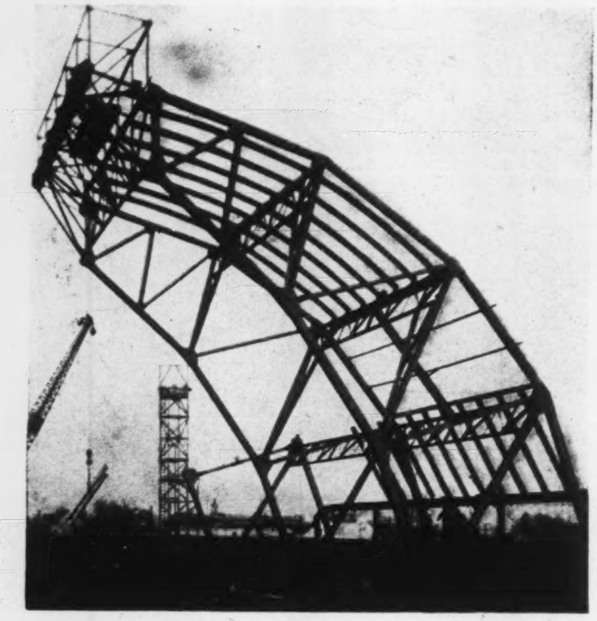


FIG. 2—ERECTION OF CANTILEVER ROOF TRUSSES

H-beam, while the boom and legs were of box lattice construction. The trusses were assembled in place after the anchorages and box-girder bases had been completed.

Timber Roof—The timber arched portion of the roof, Fig. 5, with a span of 155 ft. between the supporting steel cantilevers and a rise of 35 ft. above its springing, is said to be the largest yet built with the lamella system, which was described in *Engineering News-Record*, May 24, 1928, p. 815. It is composed of Douglas fir units 3¾x17½ in. and 15 ft. long, fitted together diagonally to form a lattice work, the units being placed on edge and having steel plate brackets at the joints. These joints are designed for a compressive stress of 15,500 lb., while samples tested at Washington University, St. Louis, Mo., are reported to have carried 55,000 lb. without failure. A sheathing of 2-in. plank is laid over both the stee and the timber portions of the roof and is covered with composition roofing. Expansion is provided for at six points around the oval by means of slotted hole connections in the steelwork and joints in the concrete floors filled with calking compound. Expansion and contraction in the wood arch roof is taken up by the "breathing" of the roof construction. Each end of the wood-arch roof is of broached or segmental dome construction, having radial ribs in line with the steel trusses, as shown in Fig. 5. These ribs are composed of three sets of units bolted together. A lattice ridge at the crown of the roof equalizes the domed ends.

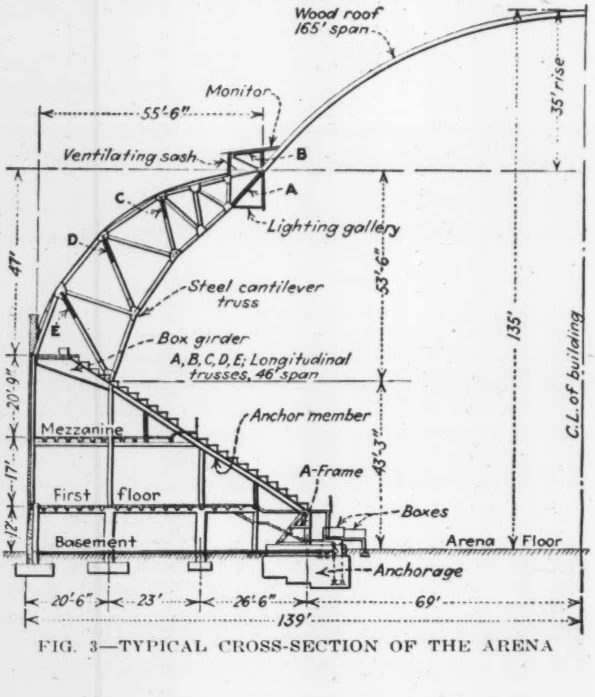

Wood roof
165' span
Monitor
55'-6"
35' rise
Ventilating sash
B
A
C
Lighting gallery
D
47'
53'-6"
Steel cantilever
truss
E
135'
Box girder
A, B, C, D, E; Longitudinal
trusses, 46' span
C.L. of building
20'-9"
Anchor member
Mezzanine
43'-3"
17'
A-Frame
First floor
Boxes
12'
Basement
Arena Floor
Anchorage
20'-6"
23'
26'-6"
69'
139'

FIG. 3—TYPICAL CROSS-SECTION OF THE ARENA

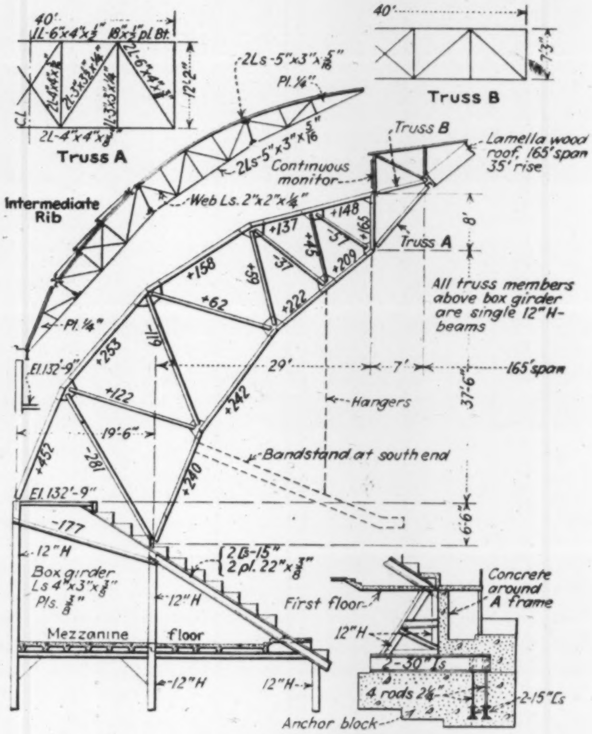

40'
1L-6"x4"x½" 18"x½" pl. Bt.
2L-4"x4"x⅜"
2L-3½"x3½"x¼"
1L-3"x3"x¼"
1L-6"x4"x½"
12'-2"
C.L.
2L-4"x4"x⅜"
Truss A
2Ls-5"x3"x5/16"
Pl. ¼"
40'
7'-3"
Truss B
Truss B
Lamella wood roof, 165' span 35' rise
2Ls-5"x3"x5/16"
Continuous monitor
Web Ls. 2"x2"x¼"
Intermediate Rib
+148
+137
+165
8'
+45
-37
-37
Truss A
+158
+69
+209
+222
All truss members above box girder are single 12" H-beams
+62
-119
Pl. ¼"
El. 132'-9"
+253
29'
7'
165' span
+122
+242
Hangers
37'-6"
19'-6"
+452
-281
Bandstand at south end
+240
El. 132'-9"
6'-6"
-177
12" H
2 ⊏-15"
2 pl. 22"x⅜"
Box girder
Ls 4"x3"x⅜"
Pls. ⅜"
12" H
First floor
Concrete around A frame
12" H
Mezzanine floor
2-30" Is
12" H
12" H
4 rods 2¼"
2-15" ⊏s
Anchor block

FIG. 4—CANTILEVER TRUSS AND FRAMING

For the erection of the wood roof, a timber staging was erected, having its first tier 40 ft. high, followed by 20-ft. tiers to the 120-ft. level, where a solid working deck was built for safety and also to permit the use of portable wooden horses for placing the units and supporting them until the arch became self-supporting. This deck was offset sufficiently to clear the sides of the arch, which extend down to the 100-ft. level. For the staging 6x6-in. posts were used to a height of 60 ft., above which the posts were 4x4 in. They were framed in pairs on the ground and set in place by a crawler crane with 70-ft. boom. At the center of the building was a 140-ft. steel mast for hoisting the units, with their joint plates attached. The erection and removal of staging, and the construction of roof (including sheathing), was all accomplished in 45 working days.

Auxiliary Features—A continuous skylight is provided along the branch of the steel-frame portion of the roof, while a monitor fitted with pivoted steel sash for ventilation is carried around the junction of the steel frame and timber portions of the roof. In the latter portion a 15-ft. ventilator opening is provided at the center point

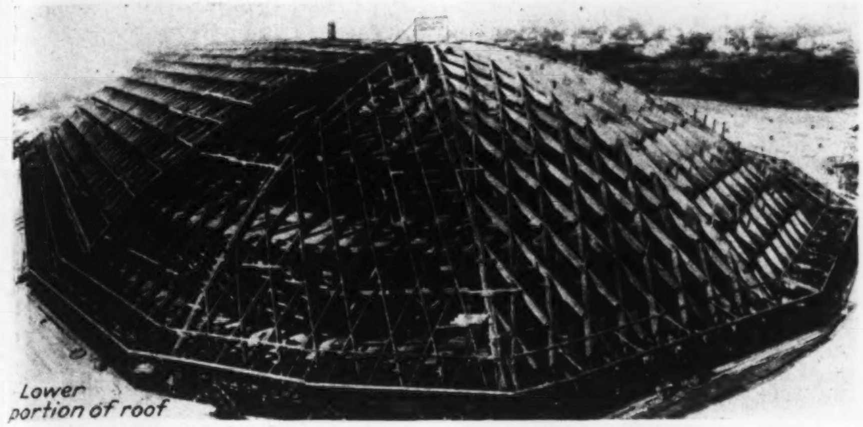


FIG. 5—WOOD ARCH ROOF OF LAMELLA TYPE
Note domed end with radial ribs. This arched roof, 155 ft. span, is carried on the ends of steel cantilever trusses.

of each domed end, while between these are ventilators along the ridge. Heating of the arena is provided by 24 forced-draft oil-burner hot-air units; a steam-heating plant serves the offices in the end of the building.

Suspended from the steel still at the springing of the wood arch roof is a gallery for floodlights, which illuminate the show ring and include color lighting effects. Lighting the seat space is provided by lamps and reflectors arranged along the outer side of the gallery. At the south end is a steel-frame bandstand large enough for 100 musicians, having its rear portion supported by the steel frame of the building, while its front end is suspended from the cantilever trusses by hangers (see Fig. 4). A terraced concrete floor gives lateral stability to this platform.

Pavilions—On each side of this main building is a steel frame pavilion 288x300 ft., composed of four 72-ft. bays with wood arch roofs of the lamella type but without the domed ends used in the arena building. Columns are spaced 20 ft. and those in the side walls are of A-frame type, to give lateral strength to the structure. They carry longitudinal members with steel sash, except that the bottom panels of the walls are fitted with rolling steel curtain doors. At the south end each bay has sliding doors 15 ft. high to give an opening 68 ft. wide. By this arrangement the pavilions can be opened on three sides in summer when used for exhibition purposes, or they can be used as sheltered parking space when only the arena building is in use. In these pavilion roofs the wood units are 2x10 in. and 9 ft. long. With a movable erection stage or scaffold, a length of 160 ft. of a 72-ft. span could be erected in an eight-hour working day.

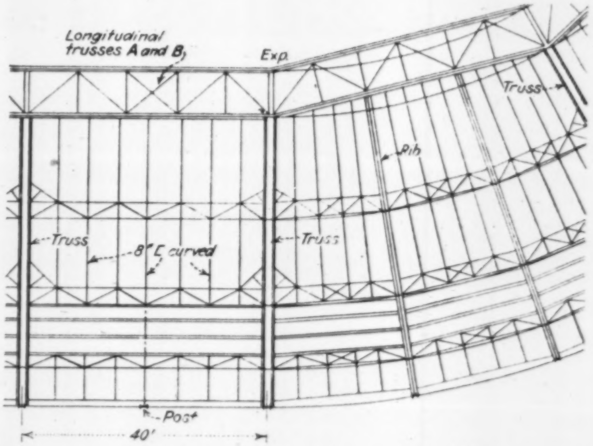


FIG. 7—PART PLAN OF STEEL FRAME

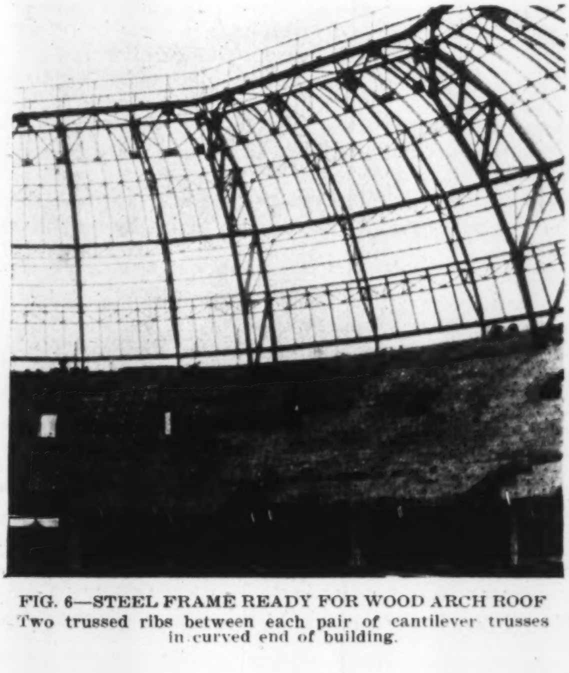


FIG. 6—STEEL FRAME READY FOR WOOD ARCH ROOF
Two trussed ribs between each pair of cantilever trusses in curved end of building.

Designers and Builders—The layout of the grounds and buildings was designed by George H. Holcombe, exhibition specialist, St. Louis, for the National Exhibition Co. James F. Parr, East St. Louis, Ill., was assistant engineer for the company, in special charge of the survey work. For the design of the buildings the architects were G. R. Kiewitt and H. M. Sohrmann, of St. Louis, with H. W. Hollingsworth, of Tulsa, Okla., as structural engineer. The general contractor was the Boaz-Kiel Construction Co. The wooden roofs were designed by the Lamella Roof Syndicate, New York, and were erected by the Missouri Lamella Roof Co. Spur tracks were laid by the Missouri Pacific Railway. The exhibition plant was opened in October, 1929.

Sydney Harbor Bridge

In the article on the erection of the 1,650-ft. steel arch bridge over the harbor at Sydney, New South Wales, it should have been stated that the bridge was designed by and is being built under the direction of J. J. C. Bradfield, chief engineer of the Sydney Harbor bridge branch of the Department of Public Works, New South Wales, Australia.

Studies in Pipe Culvert Durability and Performance

Field Inspection of Thousands of Road Culverts in Service in Half a Dozen States Is Developing a Reliable Rating Method—Co-ordination of Studies Needed

By Searcy B. Slack

Bridge Engineer, State Highway Department, East Point, Ga.

UNTIL the epoch-marking work of Dean Anson Marston and his associates at Iowa State College, there was very little information on loads actually supported by pipe culverts under fills. This work, which has been carefully checked and extended by Dean G. M. Braune, of the University of North Carolina, explains many failures of rigid-type culverts under deeper fills and formulates a method of calculating the loads to be carried by culverts under various installation conditions. Further light has been given on the structural behavior of pipe culverts by the American Railway Engineering Association in its bulletin 284, entitled "Culvert Load Determination." Splendid progress can thus be noted in studies of structural behavior of culverts. The next step is a study of the service to be expected from various materials used in the construction of culverts, or, briefly, of culvert durability.

Initial Survey Undertaken in Tennessee

Acting on this belief, the state highway department of Tennessee undertook in 1925 an extensive field inspection of culverts, and in carrying out this work a method of expressing the appearance of each structure by a numerical value of rating was developed. The field inspections showed that pipe culverts deteriorate by fairly definite stages. For example, the stages in deterioration of galvanized-iron pipe are: (1) spelter intact and spangles clearly defined; (2) spelter dark and appreciably soft, spangles obliterated; (3) spelter practically gone, thin rust forming in spots, no pitting; (4) uniform rust coat, extremely small pits, and so on by progressive steps until the metal is practically gone on the culvert invert. The schedule of deterioration, with a description of each stage and a numerical value for this stage, is called a "rating chart."

To quote the Tennessee preliminary report: "It was early seen that all culverts ultimately failed structurally but that two distinct paths of deterioration led to final failure. The corrugated-metal or flexible type usually but not always deteriorated more rapidly materially than it did structurally. The rigid type, including vitrified clay and concrete pipe, usually but not always deteriorated more rapidly structurally than materially."

The field studies leading to the formulation of numerical rating charts were made on structures of all ages available and in all service conditions found in Tennessee. Altogether, some 700 structures were inspected in this preliminary study. As a result, rating charts were formulated which were based on two premises: (1) that deterioration is at least roughly progressive; and (2) that there are certain fairly definite and recognizable stages of deterioration, to which percentage ratings can be assigned. The rating therefore expresses in percentage the worth of the culvert at the time of rating, as compared with 100 per cent when new.

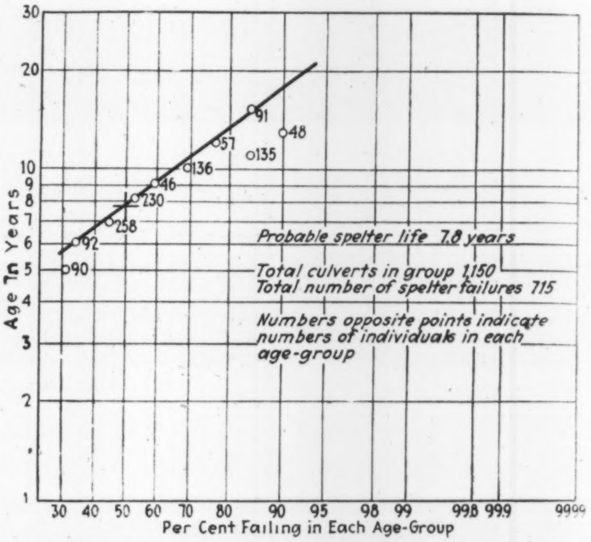


FIG. 1—PROBABLE LIFE OF SPELTER COATINGS

As determined in a particular service classification from spelter coating failures.

If deterioration is progressive and if the percentage values for the different stages of deterioration have been assigned with reasonable accuracy, there is a relation between ratings and ages at time of ratings that permits of computing an average probable life. That is, based on what has happened in the past, it should be possible to predict what is likely to happen in the future.

Although the Tennessee State Highway Department began its work on field investigations early in 1925, the work was interrupted at various times so that it was not until the summer of 1927 that it was completed. A total of 2,924 culverts, of all types commonly used in Tennessee, were included in the inspection.

In 1928, after the report was written, several hundred structures that were rated in 1925 were re-rated as a check on the values assigned to the stages of deterioration. The computed expectancies varied by only a very small percentage from those obtained from the 1925 ratings.

Starting with the rating charts formulated by the Tennessee State Highway Department and later making slight revisions, the Georgia State Highway Department in 1926 inspected and rated 2,693 culvert structures. The state highway department of Maine also made an inspection of a few hundred culverts, but the method of rating was not well developed.

In 1928 a second culvert inspection was made by the Georgia department, using the same methods that were used in 1926 and in which 1,104 of the structures rated in 1926 were re-rated. In addition, 900 structures were inspected that were not rated in 1926, because at that time they were less than four years old. Neither the Georgia nor the Tennessee highway department has considered that culverts less than four years of age should be included in a culvert investigation, as deterioration has not progressed far enough to be measured at this age.

When the average expectancies from the 1926 and 1928 ratings were compared, the greatest difference was found in the case of vitrified clay pipe. For this type, the 1928 ratings gave expectancies 9 per cent greater than did the 1926 ratings. The variations, including all types, ranged from 9 per cent to 1 per cent, and the average expectancies from the 1928 ratings were higher than those from the 1926 ratings. This indicates that the rating charts used probably give conservative results.

In order to determine what effect the personal equation might have on the field ratings, a second field party made independent ratings on 208 structures during the 1928 Georgia inspection. The maximum average difference for any one type was slightly more than 5 per cent.

In March, 1930, the Georgia State Highway Department began its third culvert investigation. It is expected that between 4,000 and 5,000 culverts will be included. For several hundred culverts there will be three ratings at two-year intervals.

In addition to Tennessee, Georgia and Maine, the state highway departments of Wisconsin, California, North Carolina and Virginia have made or are making culvert investigations. North Carolina has inspected more than 2,300 culverts, California more than 5,000 and Virginia more than 5,300. Considerably more than 20,000 culverts have thus been inspected and rated, using comparable rating charts and methods.

While this work has been going on, the Highway Research Board since 1925 has taken an active interest in the culvert investigations, and co-operating with the Bureau of Public Roads, a thorough check has been made of the so-called "rating chart" method of inspecting and rating corrugated-metal culverts. In November, 1929, an inspection of 26 culverts on the Texas Post Road between San Antonio and Austin was made by ten independent observers, including the author. E. F. Kelley, chief of division of tests, Bureau of Public Roads, following this inspection, reported:

1. The rating schedule used in his survey for measuring the relative behavior in service of corrugated sheet-metal culverts is sound in principle.
2. The use of such a schedule may be expected to yield results having a degree of accuracy sufficient for the purpose and its use by different observers may be expected to yield comparable results.

Up to the present time the Highway Research Board culvert committee has not formulated any rating charts for use with the rigid types of culverts. The repeat inspections of the Georgia State Highway Department, however, indicate that deterioration for all types is roughly progressive.

It is expected that under the active direction of R. W. Crum, chairman of the culvert committee of the Highway Research Board, studies will be made of the data already collected and that further work will be undertaken.

In 1928 the American Society for Testing Materials formed subcommittee IX of Committee A-5, for the purpose of studying corrugated-metal culvert performance. Subcommittee IX was later divided into two subcommittees, one of which was to investigate methods for making field inspections. No report on this phase of the work has yet been made.

The Armco Culvert Manufacturers Association has given considerable assistance in many of the field studies thus far undertaken and much credit is due to the engineers of this association for the work they have done. A most interesting application of the theory of probability and statistical methods to the available field data has been worked out by this association. If the field data are reasonably correct, they should respond to statistical treatment based on the laws of probability.

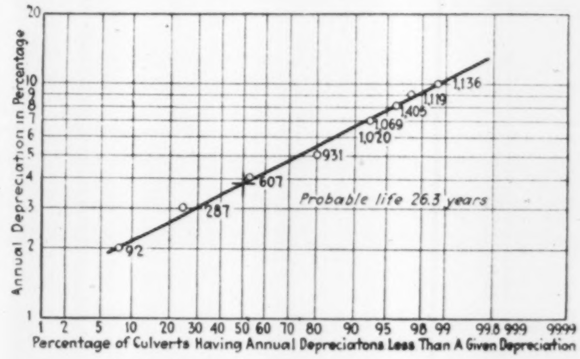


FIG. 2—PROBABLE LIFE OF CULVERTS

As determined in a particular service classification from average annual depreciation.

Hazen, Whipple and Fuller worked out a graph paper and method of plotting data (*Trans.* Am.Soc.C.E., Vol. 77) which makes it possible to determine readily whether a given set of data conforms to the laws of probability.

Fig. 1 shows this treatment applied to data on spelter failures for a group of 1,150 corrugated-metal culverts, of various base-metal classification, thought to be serving under similar conditions. Of this group 715 had passed the spelter stage. For this study the culverts are divided into age groups, and for each group the percentage of spelter failures is plotted against the age of the group. The intersection of the 50 per cent ordinate with the straight line drawn through the plotted points gives the peak or maximum value of the probability curve if drawn on ordinary cross-section paper. The probable life of spelter or galvanizing for this service condition is 7.8 years. Under the assumption that the relative worth of spelter to base metal is approximately constant for one service condition, such treatment as shown in Fig. 1 offers a logical method for classifying service conditions. The fact that the five-, eleven- and thirteen-year groups do not fall on the straight line when all other age groups do indicates that the culverts in these groups should be examined to determine "assignable causes of errors." More than likely, culverts are included in these groups that are not under the same service conditions as are the remainder of the culverts.

Since there are not enough failures of the base metal to permit of determining the probable life as was done for the spelter coating, it is necessary to use annual depreciations instead of age in years for the ordinate of the curve shown in Fig. 2. The annual depreciation is the reciprocal of the life expectancy. The same group of culverts was used as for Fig. 1. The "closeness of fit" of the points in Fig. 2 to a straight line may be considered a measure of propriety of the rating system and its application.

In summary, a method for predicating durability based on a field inspection of culverts in service has been in use since 1925. Repeat inspections, with the method of statistical treatment, are furnishing evidence that the principle is sound. It is believed that substantial progress is being made in studies on culvert durability by various agencies, and it is to be hoped that the Highway Research Board will check and co-ordinate the work which is being done.

RAILWAY GRADE SEPARATION AT MICHIGAN SUPERHIGHWAY AND MILLER ROAD
This crossing is located in the city of Dearborn and indicates the substantial and attractive structures being employed.

Progress in Superhighway Planning and Construction, Detroit Region

Over 300 Miles of 204-Ft. Highways in 21 Radial and Belt Lines Are Getting Under Way With 120-Ft. Roads on Section Lines and 86-Ft. Roads on Half-Mile Lines Within 15-Mile Circle Around Detroit

By Edward N. Hines
Chairman, Macomb-Wayne and Oakland-Wayne Superhighway Commissions, Detroit, Mich.

In the editorial, "Shall Superhighways Be of Single or Dual Pavement Strips?" in *Engineering News-Record*, Nov. 14, 1929, p. 756, the statement is made that "the Milwaukee split system will be watched with considerable interest by both Cook County, Ill., and Wayne County, Mich.," etc. Our experience here bears out your argument in favor of this split-slab design. We are of the opinion, however, that Milwaukee County received its inspiration for and information regarding superhighway construction originally from Wayne County, where the superhighway in point of planning and actual construction is farther advanced than elsewhere in the country.

The term "superhighway" was coined in Wayne County to help sell the idea to the public and has been legalized by legislative enactment. The definition of a superhighway is a road with certain widths of right-of-way. The master plan of superhighways was adopted by the city of Detroit in April, 1925, following its adoption by the county of Wayne and the adjoining counties of Oakland and Macomb, and is in reality a regional plan.

Under this plan 21 highways with a right-of-way of 204 ft. are laid out within a 15-mile circle in the Detroit region, and several of the main radials entering Detroit are carried far beyond the 15-mile circle. The approximate total length of these 204-ft. superhighways is 300 miles. All section line roads are eventually planned to have a right-of-way of 120 ft. and half-section line roads a right-of-way of 86 ft. The spacing of these planned superhighways provides equal opportunity for development in every direction.

The following fact accounts for the 120-ft. and 204-ft. rights-of-way. It is expected that at some future date Detroit will have underground rapid transit, and in order to provide space for four tubes and other necessary utilities, 120 ft. is required to obviate the necessity for shoring up or underpinning buildings. We believe that money which might have to be spent in shoring up buildings on a narrower right-of-way is better invested in acquiring the wider right-of-way on the surface. With this viewpoint, 120 ft. is set as the right-of-way on the more imporant roadways which are located on the section lines so that if it ever becomes necessary at any future time to go underground with additional rapid transit facilities, the proper right-of-way width will be available.

Rapid transit underground, when it reaches the edges of built-up areas where it might be better and more economical to bring it to the surface, requires only 84 ft. on the surface; therefore the 120-ft. highway is divided into two 60-ft. roadways and the 84 ft. necessary for rapid transit on the surface is centered thereon, giving our superhighway width of 204 ft.

To carry out these superhighway plans, the legislature has passed a law which provides that two or more counties, by a two-thirds vote of their respective boards of supervisors, may enter into a five-year contract in the creation of a superhighway commission whose personnel shall consist of members of the county road commission of each of the contractive counties. The state highway commissioner is also made a member of each superhighway commission. The commission serves without compensation, and its sole function is to acquire wider right-of-way with particular reference to intercounty roads. A half-mill tax may be levied annually by the board of supervisors in each county for carrying out the afore-mentioned function.

Two superhighway commissions have been created under the superhighway act: the Macomb-Wayne and the Oakland-Wayne superhighway commissions. The writer, who is chairman of the Wayne County road commission, is also chairman of the Macomb-Wayne and the Oakland-Wayne superhighway commissions. Money raised under this act in Wayne County may be expended in acquiring wider right-of-way on intercounty roads in either Macomb County or Oakland County, as well as in Wayne County.

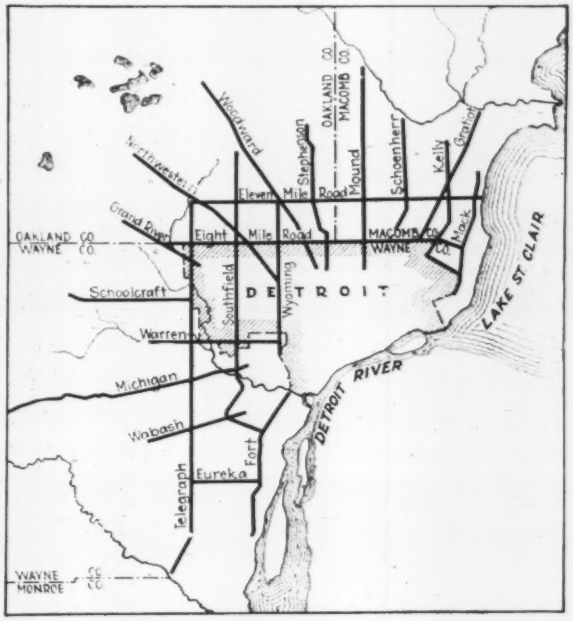
Under the master plan of superhighways wide rights-of-way which are regarded as fundamental may be acquired by dedication, by exchange of back property for frontage, by purchase or by condemnation. All of these methods have been used. More than 700 miles of wider right-of-way have been acquired to date in the three counties on the 204- and 120-ft. master plan routes, most of it by dedication, through the operation of the platting law, which provides that all subdividers must conform to the master plan in laying out subdivisions and their plats must be filed with and are subject to the final approval of the county road commission. The courts have held that this is a reasonable regulation.

The minimum ultimate development of these 204-ft. superhighways calls for two 40-ft. concrete roads with an 84-ft. space in the center for use of rapid-transit lines on the surface or other future development and a 20-ft. space on each side for sidewalks. Ultimately all railroad crossings at grades will be eliminated and the highway grades will also be separated at mile intervals.

Progress of Improvement

That this is not merely a paper plan is attested by the following accomplishment to date:

The Base Line road, which is the dividing line between the city of Detroit and Oakland and Macomb counties, is the east and west backbone of the 204-ft. master plan superhighway system. This road is nearly 23 miles long and more than 90 per cent of the 204-ft. right-of-way has been acquired. The remainder is now under condemnation in the courts. Sixteen miles of 20-ft. concrete road has been built on one side. On 4 miles there are dual strips of 20-ft. concrete pavement. By the fall of 1930 there will be dual pavement the entire distance. Two railroad grade-separation projects are also under way and one highway grade separation between Telegraph and Base Line 204-ft. superhighways is expected to be completed late in the summer of 1930. When traffic conditions warrant, 20 ft. of concrete will be added on each side.



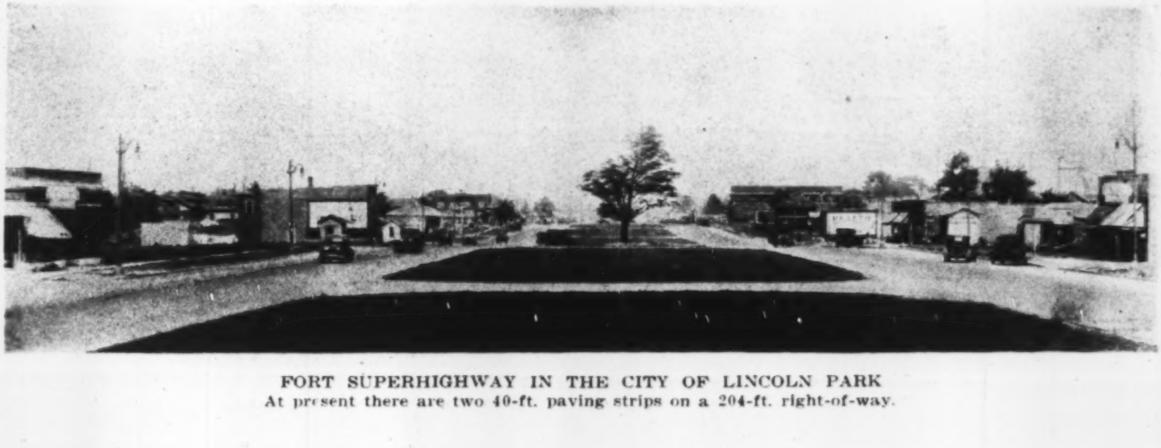
SUPERHIGHWAY SYSTEM FOR THE DETROIT REGIONAL AREA

System comprises 21 roads aggregating about 300 miles with a right-of-way 204 ft. wide.

Southfield 204-ft. superhighway is the north and south backbone of the master plan and is also approximately 23 miles long. Nine miles of this superhighway is in Oakland County and practically all of the right-of-way on this section has been acquired by dedication. A single 20-ft. concrete road serves this section at the present time. In Wayne County more than 5 miles of 20-ft. dual concrete pavement has been completed on the 204-ft. width acquired. Two railroad grade separation projects are nearing completion and one road grade separation is completed between Southfield and Michigan 204-ft. superhighways. On the remainder of the distance on Southfield superhighway, right-of-way is being acquired by dedication and purchase.

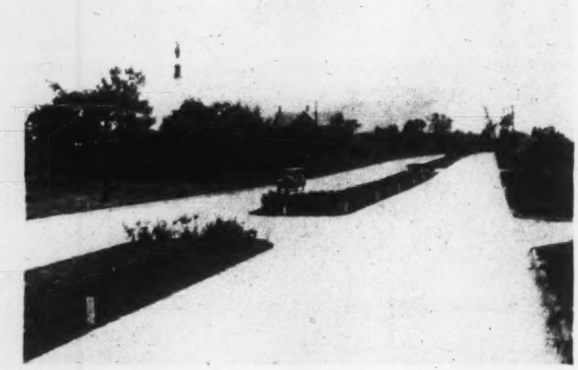
On Fort 204-ft. superhighway more than 5 miles of 40-ft. dual concrete pavement has been completed and several miles will be added during 1930. One overgrade separation with the Wabash, Pere Marquette and Pennsylvania railroads has been completed.

On Michigan 204-ft. superhighway, which is the longest superhighway in Wayne County, the entire wider right-of-way except through Dearborn and Wayne has been acquired from the limits of the city of Detroit to



FORT SUPERHIGHWAY IN THE CITY OF LINCOLN PARK

At present there are two 40-ft. paving strips on a 204-ft. right-of-way.



RIVER ROAD NORTH OF VILLAGE OF TRENTON
Two three-lane (27-ft.) pavements with center parkway planted and developed by forestry division of highway commission.

the Washtenaw County line, which is approximately 27 miles from the city hall in Detroit. Dual concrete paving strips of varying widths serve the entire distance. These varying widths of concrete will ultimately be widened to 40 ft. No railroad crosses Michigan 204-ft. superhighway at grade, although the grade separation with the Pere Marquette at the westerly limits of the village of Wayne will be widened in the near future, as it was built on the old 66-ft. right-of-way.

Grand River 204-ft. superhighway has 40-ft. dual concrete pavement for 2 miles. East of the limits of the old village of Redford there is dual pavement for a distance of more than 7 miles on a narrower right-of-way. Part of this pavement was constructed in 1921. Oakland County to the west of Wayne County is building an additional mileage of dual concrete pavement on a 204-ft. right-of-way.

On Northwestern 204-ft. superhighway there is 3½ miles of 20-ft. dual concrete pavement completed to the Oakland County line. Oakland County has 8 miles under construction, which is more than half completed.

On Schoolcraft 204-ft. superhighway the right-of-way is practically all acquired on a 9-mile stretch and construction is under way calling for an initial development of two 20-ft. concrete roadways, which will be widened later to 40 ft. as traffic demands increase.

Woodward superhighway has two 45-ft. concrete pavement strips from the Wayne County line to the city of Pontiac, in Oakland County. Pontiac is 25 miles from the heart of Detroit. On Woodward superhighway there is a long section on the east side where the construction of the second pavement strip has been held up through litigation which has recently been settled and construction work is now in progress. The Wayne County road commission is acquiring the necessary right-of-way on Woodward to carry this 204-ft. superhighway east 2¼ miles within the limits of the city of Detroit.

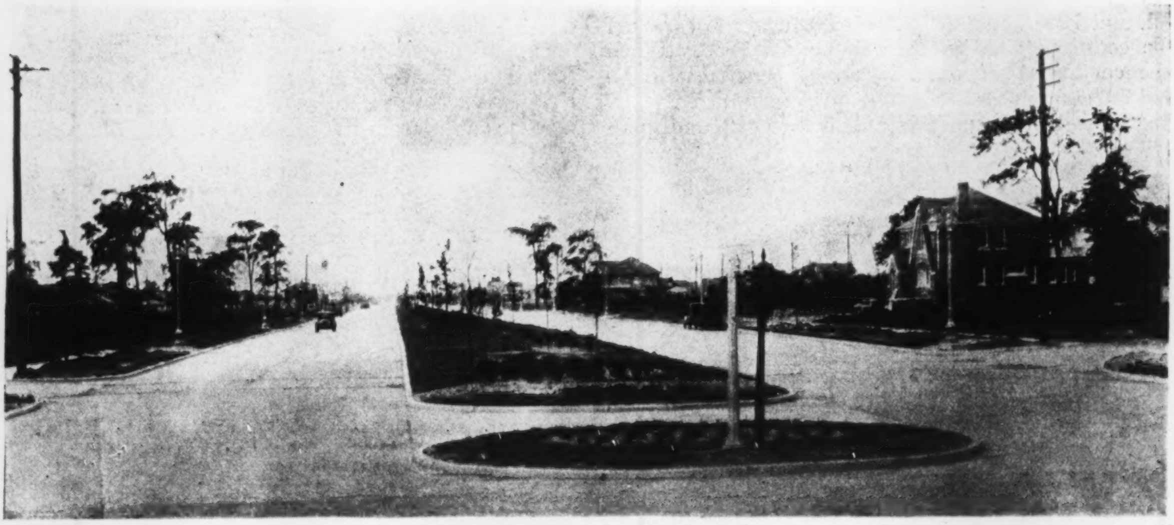
On Mound 204-ft. superhighway in Macomb County there is 8 miles of 20-ft. dual concrete pavement extending north from the Wayne County line. In Wayne County a grade-separation project is under construction on Mound superhighway. When completed, dual concrete pavement will be constructed in conformity with the development in Macomb County.

Gratiot, Seven-Mile, Kelly, Stephenson and Telegraph 204-ft. superhighways all have varying lengths of dual concrete pavement, and mileage is being added constantly during the construction season.

Boulevard Belt Line

The Wayne County road commission is also developing a "luxury" boulevard 42 miles long on a 150-ft. right-of-way encircling the city of Detroit within a radius of from 6 to 10 miles from the heart of the city. Two 36-ft. concrete dual-pavement strips are being largely used throughout, although on some sections a 60-ft. solid multiple-lane concrete pavement is used. More than 90 per cent of the 150-ft. right-of-way has been acquired by dedication, and condemnation is being resorted to for the remainder. More than 14 miles of this great circumferential Outer Drive is completed and during 1930 $2,700,000 will be invested in additional construction. One highway grade separation between the Outer Drive and Joy Road has been completed, two railroad grade crossings are completed and two others are nearing completion. Ultimately no railroad will cross this Outer Drive at grade. Trees are being planted, the parkway is being landscaped and handsome boulevard lights are being installed.

In addition to the dual pavement completed and under construction on the superhighway system, considerable



COMPLETED SECTION OF THE OUTER DRIVE
Two 36-ft. concrete pavements and a 38-ft. parkway on a 150-ft. right-of-way.

mileage of pavement of this type has been constructed on the ordinary county roads.

The first double concrete pavement in Wayne County was built in 1912 on the River Road. It consisted of two 12-ft. strips with a 16-ft. space between. These 12-ft. strips are still in use and in good condition. The 16-ft. center space was concreted in 1927 and additional concrete paving was built on each side of these old 12-ft. concrete roadways, making an over-all width of concrete of 63 ft.

Livernois Road, built in 1919, was the second road of this type built, hence the dual pavement strip is not particularly new in Wayne County. Livernois Road has been widened from 66 to 120 ft. and this past season the center space of 18 ft. separating the two old strips of concrete has been concreted, making the concrete roadway 50 ft. wide.

In addition to the large mileage of dual concrete pavements, 40 ft. has been set as the ultimate minimum width of pavement regardless of the width of right-of-way and all of the old concrete roads which are now 20 ft. or less in width are being widened to this ultimate minimum. More than 50 miles was so widened during the season just closed. There is also a considerable mileage of solid multiple-lane concrete pavement from 50 to 90 ft. in width.

The center strip on all of the roads where it is not now being used by trolley lines is being landscaped, seeded and planted with trees to give it a pleasing appearance.

Considering the fact that we have been building dual concrete pavements over a period of many years; that we have more than 93 miles of such pavement in this regional area; that we have under construction 49 miles of dual concrete pavements, all of which will be completed before the close of our 1930 construction year; that we have more than 254 miles of concrete roads of a greater width than 20 ft. wholly within Wayne County; that Wayne County is acquiring an average of a trifle more than a mile a week of wider right-of-way according to the master plan standards, Wayne County feels that it can claim with justice to be the pioneer in separated-slab construction and wider right-of-way.

Letters to the Editor

A World-Wide Challenge

Sir—The accompanying view shows an artesian well flowing 5,710 gal. a minute, or 8,250,000 gal. a day, from a depth of 780 ft., through a $12\frac{1}{2}$-in. casing. When the view was taken the valve was only partly open. The water from this well is excellent.

A Shower
In The Desert
At
Roswell, N.M.
© A.J. Hudson

Is there a well of larger capacity than this one in the world?

Lee Rowland,
City Engineer.

Roswell, N. M.,
April 2, 1930.

Politics in Engineering

Sir—Your editorial "Politics in Engineering," April 17, 1930, p. 635, while presenting evidence of political interference in the management of public works in Detroit, reveals that the engineer has obstacles to overcome, especially in the event of failures.

The engineer of late has been taking a keen interest in politics, and it is evident that as a result the public is becoming better versed in analyzing engineering features of the construction programs, brought about by the increasing numbers in population and their immediate needs.

Such whole-hearted co-operation with laymen in joining political organizations will soon bring about the recognition the engineering profession so justly deserves.

Brooklyn, N. Y.,
April 22, 1930.

J. Joseph.

Bidding on Engineering Service

Sir—On May 1, 1930, you published under "Unit Prices From Current Construction Bids" a full page of a competition wherein seventeen engineering firms responded to the calls for sealed bids at Lima, Ohio, on March 22, by I. C. Brower, city manager. There are four surprising features to this whole matter:

1. It would seem as though professional services are sought in competitive bids exactly as a city manager would buy poles, wire, cement, or any other materials, casting aside all consideration of professional services.

2. Many of the engineers entering this sealed proposal contest have heretofore on many occasions proclaimed that such participation by engineers was unethical, unprofessional, undignified and lowered the standing of the engineering profession in general. It merely goes to prove that these same engineers are not sincere, and do not practice what they preach. If procedure of this sort is publicly proclaimed and apparently has the approval of the seventeen engineers (many of them having been looked upon as exponents of high ideals and ethics), it can hardly be hoped then that young engineers of lesser standing and experience would see anything wrong in entering into a sealed proposal competition contest.

3. Many engineers have looked to *Engineering News-Record* and its editors as the exponents of ethical practice and high ideals in engineering. It is therefore all the more surprising that *Engineering News-Record* would treat these proposals in the same manner as construction bids, giving them wide publicity and uttering no protest of condemnation upon such procedure, either toward the city officials or the

engineers themselves. It gives one the impression that the *Engineering News-Record* approves of such a policy and has foresaken any hope of or effort toward raising the engineering profession to a higher level.

4. It has repeatedly been charged that city managers, especially those without engineering training, have sought engineering assistance through the medium of sealed proposals—advertising for engineers the same as they would for construction or materials—probably through the desire to impress their councils and commissions with the fact that they are getting the services desired, under competitive bid, as cheaply as possible. But unless engineering journals and engineers themselves have a higher regard for their own profession and ethics, we can hardly expect city officials to treat engineering services different from any other commodity purchased.

R. E. McDonnell,
Burns & McDonnell Engineering Co.,
Consulting Engineers.

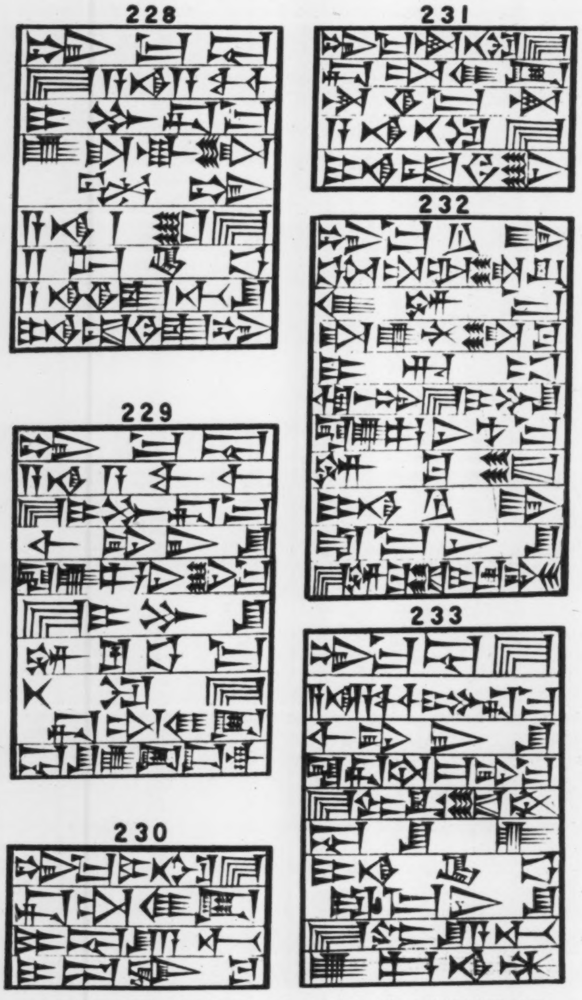
Kansas City, Mo.,
May 24, 1930.

An editorial discussion of the Lima bidding appeared in our issue of May 29. The above letter was received too late to be considered in that discussion.—Editor.

The Building Code of Hammurabi

Sir—The editorials in *Engineering News-Record*, "The Designer Responsible" (p. 386, March 6, 1930) and "Manslaughter" (p. 508, March 27, 1930), brought to my mind the building code which is included in the Code of Hammurabi.

This code has been referred to many times in connection with building code legislation, but I do not recollect seeing the complete text reproduced in that connection. The accompanying autographed text and translation of the section of the code referring to building are taken from Professor Harper's book ("The Code of Hammurabi, King of Babylon about 2250 B. C.," by Robert Francis Harper, Ph.D., University of Chicago Press, 1904).



AUTOGRAPHED TEXT OF CODE OF HAMMURABI

It is interesting to note that the very strict responsibility of the builder as laid down by Hammurabi some 4,200 years ago follows the section which prescribes that the builder shall be paid for his labor.

Building Code From the Code of Hammurabi, King of Babylon, About 2250 B. C.

228—If a builder build a house for a man and complete it, (that man) shall give him two shekels of silver per sar (approx. 12 sq.ft.) of house as his wage.

229—If a builder build a house for a man and do not make its construction firm, and the house which he has built collapse and cause the death of the owner of the house, that builder shall be put to death.

230—If it cause the death of a son of the owner of the house, they shall put to death a son of that builder.

231—If it cause the death of a slave of the owner of the house, he shall give to the owner of the house a slave of equal value.

232—If it destroy property, he shall restore whatever it destroyed, and because he did not make the house which he built firm and it collapsed, he shall rebuild the house which collapsed from his own property (i.e., at his own expense).

233—If a builder build a house for a man and do not make its construction meet the requirements and a wall fall in, that builder shall strengthen that wall at his own expense.

L. B. Tuckerman,
Assistant Chief, Division of Mechanics and Sound,
U. S. Bureau of Standards.

Washington, D. C.,
April 19, 1930.

Does Welding Affect Steel Injuriously?

Sir—I note discussion on p. 820 of the May 15 issue of *Engineering News-Record* concerning the effect of flame-cutting on steel.

There seems to be wide difference of opinion among engineers with reference to change in the molecular constitution of steel plate after it has been welded by the electric-welding process. We have found that some engineers are strongly in favor of annealing or normalizing arc welds. I know that in a few cases specifications containing this as a requirement have been the result of unscrupulous competitors attempting to load up cost on welded pipe, but there does no doubt exist ample argument on the subject based on facts surrounding the behavior of welding done on materials of questionable carbon content and by processes not controlled.

Are you in possession of any data indicating that arc-welded plates are not improved or in any material way changed by later annealings? I have in mind plates ¾ in. in thickness and of low carbon content, similar to A.S.T.M. specification A-78-27, grade A or B.

We have produced hundreds of thousands of feet of electrically-welded pipe and vessels, and have developed our welding procedure to the point that on material 1½ in. thick and under, of the proper carbon content, normalizing or annealing of the weld is unnecessary. Welded vessels made under our procedure control are accepted for insurance by the Hartford Steam Boiler Inspection and Insurance Co. without the annealing requirement; this acceptance followed many months of tests at our plant.

I am inclined to feel that some of the difficulty encountered in the earlier days was due to lack of proper selection of materials, proper method of getting materials ready for welding, and lastly proper control of the variables encountered in the welding operation itself. The question of annealing was probably considered as a cure-all for the other deficiencies.

Statements from metallurgists or welding engineers on this question would be appreciated.

F. G. Sherbondy,
Briggs Boiler Works Co.

Akron, Ohio,
May 20, 1930.

News of the Week

Boulder Dam Power Contract Modified

By request of the congressional committee considering an appropriation for the Boulder Canyon project, a modification of the power contract was made last week by the several parties at a meeting in Los Angeles. The modification assigns any unused surplus of the Metropolitan Water District's allotment to the city of Los Angeles and the Southern California Edison Co. and associated companies. All allocation percentages remain as heretofore.

New Tunnel Under Thames Is Proposed

A bill promoted by the Kent and Essex county councils for the construction of a new tunnel under the Thames to connect Dartford and Purfleet has been approved by a select committee of the House of Commons. The Port of London Authority thought such a tunnel might interfere with future requirements of shipping, but the promoters have met this objection by providing that the crown of the tunnel shall be 56 ft. 9 in. below low-water level. The estimated cost of the tunnel is £3,000,000 ($15,000,000). The two county councils will provide £500,000 and the Ministry of Transport £2,250,000. A clause in the bill enables local authorities to contribute, and it is hoped that the remainder of the £3,000,000 will be made up in that way. The tunnel will have a road 19 ft. wide, with headroom for double-decked passenger buses.

Court Orders Union Station for Los Angeles Railroads

The California Supreme Court, in a decision rendered on May 28, upheld the order issued by the state railroad commission on July 8, 1927, directing the Southern Pacific Co., the Atchison, Topeka & Santa Fe Railway Co. and the Los Angeles & Salt Lake Railroad Co. to construct and operate a union terminal station in the Plaza area of Los Angeles. The estimated cost of this union terminal, together with the elimination of 23 heavily traveled grade crossings in the heart of Los Angeles, is $10,000,000.

San Francisco to Vote on $68,115,000 Bond Issue

At a meeting held May 26, the San Francisco board of supervisors by a vote of 15 to 3 approved the recommendation of the joint finance and public utilities committee that the voters of San Francisco be asked to approve at the primary election to be held Aug. 26 the issuance of bonds totaling $68,115,000 to purchase the local distributing systems of the Pacific Gas & Electric Co. and the Great Western Power Co., to make necessary immediate improvements and to construct a new power plant. Four bond issues will be placed upon the ballot as follows: for purchase of P.G.&E. system, $44,600,000; for purchase of Great Western Power system, $18,945,000; for necessary expenditures (five items), $3,525,000; and for Red Mountain Bar power plant, $1,045,000.

The necessary expenditures as determined by the joint committee include $1,190,000 for transmission line, Newark to San Francisco; $730,000 for necessary changes in step-down stations; $670,000 for interconnecting lines; $900,000 for construction of new downtown substation and $35,000 for cutting over the Phelan Building station load.

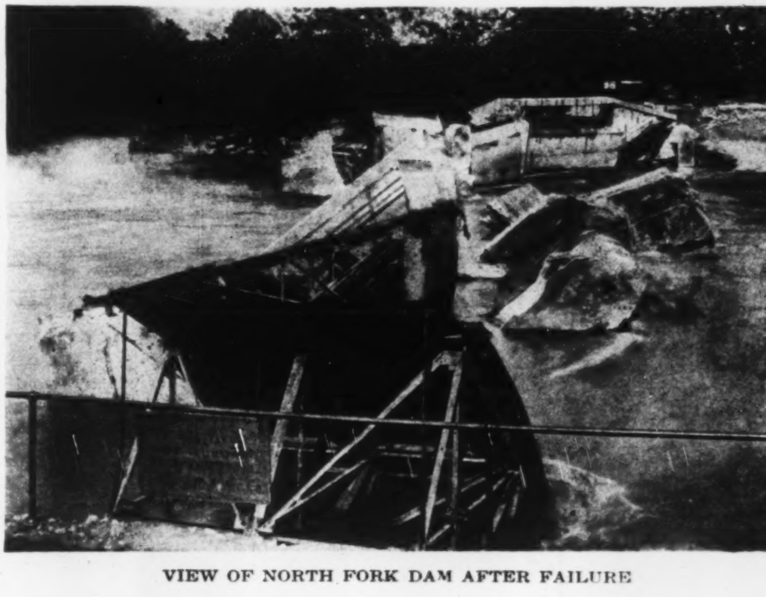
Health Institute Assured

President Hoover on May 26 signed a bill providing for the creation of a National Health Institute in Washington under the auspices of the United States Public Health Service. The measure authorizes an initial appropriation of $750,000 for the construction and equipment of buildings, and the secretary of the treasury is authorized to accept donations for use in ascertaining the cause, prevention and cure of disease affecting human beings. The establishment of research scholarships within the institute is provided, the scientists to work both here and abroad.

Water-Works Dam at Danville Fails by Sliding

The North Fork concrete dam of the Interstate Water Co. at Danville, Ill., collapsed entirely at about 3:30 a.m. on May 21, draining the reservoir at the pumping station. This dam, as built originally in 1903, was of plain or unreinforced concrete, straight in plan, 174 ft. long and 9 or 10 ft. high, with its foundation about 3 or 4 ft. below the bed of the stream and having no underdrains. In 1910 it was raised about 3 ft., the new concrete being 30 in. thick against the vertical upstream face and sloping back to join the slope of the downstream face of the old structure. At the same time four tainter gates 10x14 ft. were placed along the top, supplemented a few years later by a 3-ft. flashboard operated from a footbridge. This enlargement, exclusive of the flashboards which increased the height and load, was designed by Mead & Seastone, consulting engineers, Madison, Wis., and was built by the Western Concrete Construction Co.

According to a statement by John F. Fisher, civil engineer, Danville, who has furnished information as to the dam and its failure, an examination of the wreckage shows that there were numerous signs of old cracks in the concrete and places where the new concrete was not properly bonded, although these weak points were not easily to be seen or detected before the structure failed. Furthermore, the concrete, made with local gravel, is thought to have been deficient in coarse aggregate. The foundation was a water-bearing shale, but no underdrainage was provided. In



VIEW OF NORTH FORK DAM AFTER FAILURE

view of the weakness of the concrete, the probable upward pressure of water under the dam and the fact that in winter the water was held to the top of the gates or even higher by ice, Mr. Fisher considers that the strain caused the concrete to crack more and more each year until it failed. The failure was mainly by sliding on the base. Some parts of the dam were only pushed out of position, while others were overturned, as shown in the accompanying view. It is apparent that the failure was slow, releasing the water gradually, as no damage was done along the river below the dam. Steps were taken at once to build a timber dam about 250 ft. upstream and to extend the intakes to a temporary intake. Martin M. Symons is chief engineer of the Interstate Water Co., with H. M. Ely as superintendent of water-works. Plans for construction of a new dam are being made by Mead & Seastone. This failure did not seriously affect the water supply, as a higher dam was constructed a few years ago, the old dam serving mainly to reduce the suction lift and to provide storage near the pumping plant.

Boston Municipal Airport to Be Enlarged

Governor Allen, of Massachusetts, has signed the bill permitting the state department of public works to lease additional land to the city of Boston for the development of the Boston municipal airport. This makes possible the immediate development of the airport to the minimum requirements for a Class I rating on size from the Department of Commerce. The land which can be leased under the bill lies to the east and northeast of the airport and the developments contemplated this year will give clear approaches over water in all directions except the north.

Highway Safety Considered at Third National Conference

Establishment of a National Traffic Foundation to study problems of congestion, the stability of property values and the orderly development of urban communities was recommended by the third National Conference on Street and Highway Safety, in session May 27-29, at Washington, D. C. The conference adopted a resolution requesting Secretary of Commerce Lamont, as president, to appoint a committee to consider ways and means of establishing such a non-governmental research agency to co-operate with existing educational and research institutions.

The conference also urged legislation by Congress to permit governmental agencies such as the Bureau of Public Roads to conduct research and experimentation in developing measures for the relief of congestion and to cooperate in this problem with municipal and other local authorities.

The desirability of empowering some central government agency to conduct co-operative research in this field and to co-ordinate and make available the results of these and similar studies was urged in the report of the committee on measures for the relief of traffic congestion submitted by E. J. Mehren, its chairman.

Recognizing that traffic congestion is not a necessary evil, the conference also adopted other recommendations made by that committee with a view to alleviating a condition which, according to conservative estimates, is costing the American people two billion dollars a year. Foremost among these recommendations are: (1) that every city faced with serious traffic problems should have a permanent traffic commission with appropriate official and citizen representation, and (2) that such cities should employ an engineer with specialized traffic and transportation experience. In support of these recommendations, the committee stated that sound engineering advice, coupled with continuing traffic surveys, is essential in planning for future requirements for adequate handling of the traffic problem.

Specific remedies were proposed by the committee embracing both immediate relief measures and a program of permanent improvements, including the control of land use, which recognize that the three fundamental causes of traffic congestion are inefficient and conflicting use of available street and highway space, excessive demands upon inadequate street and highway systems and too intensive use of the abutting land.

The conference approved the report of the drafting committee embracing the principal recommendations made by other committees of the conference with reference to the protection of highway grade crossings and highway intersections, maintenance of motor vehicles, traffic accident statistics and uniform traffic regulation. The committee on uniform traffic regulation will be continued in effect to perfect amendments approved by the conference to the uniform traffic code, the model municipal traffic ordinance and the report on street traffic signs, signals and markers. These will be referred to the National Conference of Commissioners on Uniform State Laws.

On the recommendation of the drafting committee, the conference rejected the proposal made by the committee on uniform traffic regulation to eliminate from the code restrictions on vehicle speeds in terms of miles and permit speeds which are safe and reasonable under existing traffic conditions, with the occurrence of an accident as prima facie evidence that the speed was unsafe and unreasonable.

EXHIBIT BLDG "A"
ARENA
EXHIBIT BLDG "B"

WHERE THE 1931 ROAD SHOW WILL BE HELD

St. Louis, Mo., was selected as the location for the 1931 convention and road show of the American Road Builders' Association at the annual business meeting held recently in Washington, D. C. The Arena, where the exhibition will be held, is 475 ft. long and 276 ft. wide, with a distance from the floor to the highest point in the roof of 135 ft. The center roof span of 165 ft. is of the lamella type, supported by twenty cantilever steel trusses. Auxiliary buildings, 300x288 ft., will house additional exhibits.

New Refuse Incinerators for Washington, D. C.

Plans for the construction of two large refuse incinerators are under way in Washington, D. C., following the appropriation by Congress of $850,000, of which $550,000 is immediately available. The new plants will handle only the city trash collections and street sweepings. Garbage will continue to be put through the reduction system.

Availability of funds is as follows: purchase of two sites, $245,000; two plants, $500,000; additional collection equipment, $80,000; engineering, $25,000. The latter sum goes by contract to Metcalf & Eddy, who will make an estimate of requirements to determine size and type of plants, draw plans and specifications, assist in awarding construction contract, and test the plants on completion. One of the sites is in the southeast section of the city near the navy yard and the other is in the northwest section in lower Georgetown. Both are near a railroad and front on the Potomac River.

N. Y. Engineers Lose Fight Over Multiple Dwelling Law

By a unanimous decision the New York Court of Appeals has decided that plans for multiple dwellings in New York City must be filed by the owner in person or by a registered architect. The case was brought to the highest court on appeal by Oscar Goldschlag, who attacked the validity of section 300 of the multiple-dwelling act. Goldschlag, for sixteen years a professional engineer in New York, claimed that rejection of plans filed by him with the tenement house commissioner constituted an invasion of his constitutional rights. Without opinion, the court rejected this contention.

Tacoma to Contract for Additional Power

A contract between the city of Tacoma and the Puget Sound Power & Light Co. covering an exchange of power in case either party to the contract finds itself short of power on account of drought or other cause has been agreed upon, Commissioner Ira S. Davisson, of the public utilities department, has informed the city council. The corporation counsel has been directed to proceed to get the contract in form for action, the council having approved the step.

Florida to Burn $10,000,000 Everglades Bond Issue

The Florida Internal Improvement Board has voted to burn the $10,000,000 issue of bonds the proceeds of which were to be used to finance reclamation work in the Everglades. These bonds, authorized by the legislature and held valid by the State Supreme Court, were never floated, because one member of the cabinet of former Governor Martin whose signature to the papers was necessary, declined to sign them.

Easton, Pa., to Have Airport

The International Airports Corp., New York City, has signed a contract with the Easton Airport Corp. for the construction of a major commercial airport at Easton, Pa. Ultimate expenditure exceeding $500,000 will be made in the complete development of this airport, which will serve the district of Easton, Pa., and near-by cities and communities. Work will start immediately. The International Airports Corp. will also act as operating manager of the airport over a period of years.

Road Construction in the United States Increases

Highway construction in this country shows a large increase in contract awards for the first quarter of 1930, according to reports of governors of 35 states to Secretary of Commerce Lamont. The figures show contracts awarded during the first quarter of this year valued at $114,101,383, against $50,910,133 for the similar period of last year.

Pennsylvania leads in dollar total increase, with contracts awarded valued at $15,469,853 for the first quarter of 1930, against $2,282,813 for the same period of 1929. Other large totals were: Iowa, $11,232,268; Missouri, $10,699,657; and Virginia, $9,000,000. These four states provided more than 40 per cent of the total value of contracts awarded.

American Institute of Architects Favors Closer Co-operation

Closer co-operation with the building industry was a feature at the 63d convention of the American Institute of Architects in Washington May 21-24. Better building codes, safety in construction, buildings more applicable to conditions, and the development of new materials were included in the program. Progress was reported in plans toward the preservation of national monuments and historic spots. Satisfaction was expressed with the placing of plans for public buildings along Pennsylvania Ave., Washington, under supervision of the Fine Arts Commission in accordance with the trend toward similar boards to govern sections of other cities.

That construction accidents are increasing rather than declining under modern methods was brought out by one report. Speed in demolition and erection with resultant carelessness was cited as the proximate cause. This is due, the report stated, both to economic pressure necessitating quick completion, especially of larger buildings, and to the propensity of foremen and superintendents to push the work to make a satisfactory personal showing. A case was cited where 54 accidents occurred in the demolition of a large New York building. Injuries caused by falling objects are largely preventable, the report declared. Conditions are creating a stimulus toward more rigid safety codes such as are being developed by the National Safety Council and by the A.I.A.

At the jointly held meeting of the Producers' Council, representing 60 building-materials groups, convening for the seventh year, the development of new materials better suited to use in modern architecture, together with the future application in design of such materials, formed a major topic of discussion. Several new sets of building codes were submitted. These were drawn with the hope that as some 25 cities are now revising their codes some of the plans suggested might be suitable to form an integral part of such systems in accordance with the plans of the A.I.A to push unified building regulations throughout the country. No definite approval of the codes so far formulated was made at this time.

Election of Robert D. Kohn, of New York, as president of the Institute was announced at the annual dinner. Mr. Kohn, who succeeds C. Herrick Hammond, of Chicago, defeated J. Monroe Hewlett, of New York, and Charles A. Favrot, of New Orleans. Mr. Kohn was graduated from the Columbia University school of architecture in 1890 and studied at the Ecole des Beaux Arts, Paris. He has served as vice-president of the Institute and as president of the New York Chapter. He is associated with Charles Butler in the practice of architecture.

Other officers chosen are: first vice-president, Ernest John Russell, St. Louis; second vice-president, Horace W. Peaslee, Washington; secretary, Frank C. Baldwin, Washington; treasurer, Edwin Bergstrom, Los Angeles.

Wide World Photo

WORLD'S LARGEST COMMERCIAL BUILDING COMPLETED

Tenants are now moving into the Merchandise Mart, Chicago's new air-rights building, the construction of which was described Sept. 12, 1929, p. 420. More than 4,000,000 sq.ft. of rentable floor area is contained in the eighteen-story main structure and the 25-story tower section.

B.&O. to Buy Control of Buffalo & Susquehanna

Another link in the Baltimore & Ohio Railroad's proposed new route between New York and Chicago was effected May 21 when the Interstate Commerce Commission issued an order authorizing it to acquire control of the Buffalo & Susquehanna Railroad. A 55-mile segment of the Buffalo & Susquehanna will be used in the new through route proposed by the B.&O., which will effect a considerable saving of time and distance between New York and Chicago as compared with existing B.&O. trackage.

Dallas Approves New Electric Generating Station

The board of commissioners of the city of Dallas, Tex., has approved the application of the Dallas Power & Light Co. to build a new electric generating station and to create a lake in Mountain Creek territory a few miles west of the city limits of Oak Cliff. The cost of the project is estimated at $8,587,541.

The immediate proposal is to install one 35,000-kw. machine in the new building and add others as later years' demands may require, until the present plant and the new plant have a total capacity of 200,000 kw.

The lake which it is proposed to create will submerge an area of about 4,259 acres and will be about 1½ miles wide and 4½ miles long. It will be created by building an earthen levee or dam about 1,800 ft. long with average height 22½ ft., impounding the rainfall resulting from about 300 square miles of drainage area.

It is proposed to turn the lake and the adjoining lands over to the control of the city for recreation purposes, under rules to be agreed upon between the city and the power company.

The power company has a limited time in which to accept the conditions under which the application is granted.

6,000,000-Gal. Steel Reservoir Near Rochester Completed

The new 6,000,000-gal. steel reservoir of the Rochester & Lake Ontario Water Service Corporation at Cobb's Hill, near Rochester, N. Y., recently completed, is said to be the largest steel reservoir in America and the only one with a welded-steel plated bottom. Water will be pumped into the new reservoir from the company's station at Charlotte, N. Y.

The tank is 200 ft. in diameter and consists of four rings, the plates of the first or lowest being 1 in. thick, and each being 25 ft. long and 6½ ft. wide. To use this storage the company is now connecting the steel tank through 24-in. mains.

Cement-lined, cast-iron pipes have been laid for 4,620 ft. The iron conduits will be placed in 48-in. concrete culverts now being laid beneath the tracks of the New York Central R.R. The welding of the bottom plates was done by the Chicago Bridge & Iron Co., of Chicago, Ill. The company will build a 200,000-gal. standpipe to take care of the peak demands in the industrial and residential sections of Gates.

The Business Outlook

The influence of seasonal slackening in industrial activity is more apparent. General trade shows no marked improvement, and prices continue weak. Steel ingot production is slightly below 74 per cent of capacity. The rate of decline is about the same as last year at this time. Electric power production continues practically at the level of a year ago, but is still nearly 2.5 per cent above normal for the season and the year.

—The Business Week, June 4.

Oklahoma Water-Works Short Course Held at Stillwater

All previous records for attendance were broken at the sixth annual meeting of the Oklahoma Water-Works Short Course, held at Stillwater under the joint auspices of the Oklahoma Water-Works Conference, Oklahoma A. & M. College, Oklahoma State Health Department and the Oklahoma Department of Vocational Education. The course was preceded by a 600-mile inspection trip of water and sewage plants in the various cities of the state. Electrical equipment for water plants was discussed and considerable time was devoted to discussion of water softening by zeolites. Much interest was shown in the discussion of sewage-treatment problems and in the operation reports which were presented, particularly as to the cost of operation of the mechanical plants.

Officers for the coming year were elected as follows: president, Fred Cowell, Vinita; vice-president, C. H. Harrison, Enid; secretary-treasurer, H. J. Darcey, Oklahoma City. Clarence Bullen and H. J. Darcey were selected as representatives of the conference on the board of control of the Federation of Sewage Works Associations.

Second Dam on Pend Oreille River in Prospect

The water board of British Columbia has granted to the West Kootenay Power & Light Co., Rossland, B. C., the right to proceed at once with surveys for the construction of a 150-ft. dam near the mouth of the Pend Oreille River. The company already has the right to erect a 155-ft. dam farther up the river. This second concession virtually gives the company control of the stream.

Brief News

WARSAW, POLAND, is planning to construct a new central railway station and to electrify all suburban lines at a cost of approximately $9,000,000.

A NEW BUILDING CODE has been adopted by the city of Syracuse, N. Y., as the result of two years of work by a special committee.

CONCRETE HIGHWAYS in Hungary are assured by the appropriation of $6,000,000 for the work. A special commission will be sent to the United States to study American methods.

TOLLS on the Delaware River bridge, connecting Philadelphia with Camden, N. J., in 1929 amounted to $3,331,781.26, and it is predicted that the cost of the bridge will be paid for by the tolls by 1937.

AN ADVERSE DECISION has been rendered by the Pennsylvania Supreme Court in the attempt of the city of Williamsport to acquire the Williamsport Water Co. at a price as of Nov. 1, 1918.

OPENING of Texarkana's (Ark.) new $2,000,000 union station took place on May 12. The station will be used by four railroads, the Missouri Pacific, the St. Louis Southwestern, the Texas & Pacific and the Kansas City Southern.

EUROPEAN RAILWAY CONSTRUCTION planned for the near future includes the building of a 200-mile railway between Ferrol and Gijon in northern Spain, and of an electric railway from Belgrade to Semlin, Yugoslavia.

BIDS FOR HARBOR IMPROVEMENTS at Saloniki, Greece, amounting to approximately $11,000,000, are now being studied by a special commission appointed by the government preparatory to making an award.

DELAYS on the London, England, underground railways amount to only four minutes per 10,000 miles run, according to a statement made at the annual meeting of the combined companies.

THE CITY COUNCIL of Tacoma, Wash., has passed an ordinance providing $20,000 for the enlargement of the old Tacoma substation of the municipal light department. Work will be done by day labor.

THE CANADIAN NATIONAL RAILWAYS has been authorized by the Dominion Parliament to expend a further sum of $3,650,000 on its Toronto terminals, bringing the total expenditure on the part of the railway on this work to approximately $17,000,000.

AUTHORITY TO RAISE RATES 20 per cent has been granted by the New Jersey Public Utility Commission to the Hackensack Water Co. The commission also ruled that consumers must bear the cost of the legal work on behalf of the company in the rate case, which, it was stated, amounted to $111,263.

Texas to Redeem 69,000 Acres by Irrigation

All requirements of the Texas State Board of Water Engineers have been met by the Hidalgo County Water Control and Improvement District No. 12, and the board has granted a permit for the construction of a system of irrigation to embrace 69,373 acres of land. The water supply will be obtained from the Rio Grande and only storm and flood waters of that stream will be used, according to provisions of the permit. The tract to be irrigated is located in the Lower Rio Grande Valley. The district has already issued $5,500,000 of bonds for carrying out the necessary construction work.

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

Chief of Engineers Suggests Board of Experts to Pass on Changes in Jadwin Plan

BEFORE amendments to the flood-control act are recommended to Congress, Major-Gen. Lytle Brown, Chief of Engineers, believes proposed changes in the Jadwin plan should be submitted to a new board of review. He is willing that this board consist of engineers outside of the government service, but in the course of testimony on June 3 before the flood-control committee of the House, he urged that it be made clear that only men of real eminence should be appointed to the board.

General Brown expressed the opinion that the committee has the authority by simple committee resolution to set aside the report of the former board of review, which was composed of General Jadwin, General Jackson and Carlton W. Sturtevant. No changes in the flood-control plan can be undertaken intelligently, he told the committee, unless surveys and studies now under way are completed. The results of most of these studies will be known late this year and early next year. He declined to draw conclusions from the data already in hand, but he said that nothing in the returns thus far received would indicate that the Boeuf Basin floodway and the Atchafalaya floodway can be omitted from the plan; it may be possible, he said, to alter somewhat the character of those floodways. In its fundamentals the plan is sound, General Brown told the committee. He expressed the opinion that any changes in the plan that may be made in the future will be in the details of the plan rather than in its major features.

When members of the committee attempted to question General Brown on economic phases of the flood-control plan, Chairman Reid objected on the ground that the engineers should be called upon for engineering information only and that the committee and Congress should determine economic questions involved. To this Representative Wilson, of Louisiana, the ranking minority member of the committee, took exception, saying that Congress is accustomed to look to the engineers for much information on economic matters and that the committee should have the benefit of the thought of the engineers as to whether or not the government should pay for lands abandoned to the river by the relocation of levees.

Potomac Park Bill Signed

The Cramton-Capper bill providing for park development in the gorge of the Potomac above Washington, which has been signed by the President, reserves for future determination by Congress whether or not power will be developed at Great Falls. This phase of the bill was much contested in the hearings before the Senate and House committees. Those favoring power development contended that a hydro-electric plant would not interfere with the beautification plan.

Major Brehon Somervell, district engineer at Washington, supported the proposals for power development. In a report prepared by him and approved by the Chief of Engineers, he brought out that the construction of hydro-electric dams would enhance the park development by the formation of lakes. He pointed out in his report that the formation of lakes would bring the water up to a level so that riverside drives could be constructed, which would be impossible on the steep sides of the gorge with a low-level park.

Offers were made by Byllesby company, which was interested in power surveys on the Potomac, to turn over a free park to the government in consideration of the construction of dams. It is generally conceded that it will be virtually impossible to obtain permission from future sessions of Congress to construct a hydro-electric plant on the Potomac above Washington. Efforts are being made to obtain initial appropriations for the park development in the second deficiency bill now being considered by the appropriations committee.

Cement Practices Under Fire

Dismissal by the Federal Trade Commission of its complaint against the Portland Cement Association and its membership was urged at a hearing May 29. Counsel for the association argued that the commission had no jurisdiction to prosecute charges that the cement manufacturers have been guilty of unfair methods of competition in disparaging and discrediting the method of concrete road construction controlled by the American Vibrolithic Corp., of Des Moines.

The commission's complaint against the association was issued in July, 1928. Some testimony has been taken, but counsel for both sides agreed that rather than bring the case to trial on its merits, the question concerning the commission's jurisdiction should first be determined.

Don K. Jones, the association's attorney, claimed that the commission has no jurisdiction over the practices alleged in its complaint, because the cement manufacturers do not bid on road contracts or build the roads, and because the interstate shipment of cement by them, as well as of machinery by others, is merely incidental to the activities of contractors or builders. He contended that when a county board of supervisors awards a road contract it is an intrastate transaction beyond the reach of the commission's jurisdiction. Edward A. Haycraft, the commission's attorney, argued that interstate commerce is directly affected if, as the result of the representations made by the cement manufacturers, the shipment of particular machinery is interfered with.

National Museum of Engineering and Industry

Recent developments in the Senate committee on education and labor indicate that action will be taken on the Copeland bill for the establishment of a national museum of engineering and industry. A subcommittee has been considering the bill and it is now reported that favorable recommendations will be made to the Senate by the full committee. Senator Copeland's bill contemplates the establishment of a suitable museum for engineering and industrial exhibits and authorizes creation of a commission to study the matter.

Naval Appropriations Bill Passed

An item of $175,000 for the engineering experiment station at Annapolis is provided in the naval appropriations bill that passed the Senate last week. The measure already has received the approval of the House. The bill also provides $85,000 for further lake and ocean hydrographic surveys. A total appropriation of $20,101,400 is carried for the Bureau of Engineering, of which $750,000 is to be used for the procurement and installation of new tools. In the section of the bill relating to the operations of the Bureau of Yards and Docks many projects are authorized for construction, dredging and the extension of public works at the various navy yards.

One of the largest dredging operations will be at the Philadelphia navy yard, where $100,000 will be used for the continuance of the work, including work on dry docks and piers. The total operations at the Philadelphia navy yard that fall under the jurisdiction of the Bureau of Yards and Docks will amount to $453,000. For the improvement of the waterfront of the New York navy yard $150,000 is provided, and $100,000 for the continuance of dredging at this station. On the Pacific coast, the largest amount will be spent at Mare Island navy yard. The total appropriation for improvement work at this naval station amounts to $667,000. For the improvement of old buildings $60,000 will be used; $300,000 will be used for the improvement of the waterfront, and $132,000 has been provided for a power plant and distributing system.

Oakland, Calif., to Have New Municipal Pier

A new municipal pier to cost approximately $1,250,000 is under construction at the foot of Ninth Ave. in the Brooklyn Basin, Oakland harbor, Oakland, Calif. It will be 1,521 ft. long and 224 ft. wide, making berthing space for three large vessels available at this terminal. Steel and concrete construction will be employed throughout. For the present needs of the pier, a single shed 504 ft. long and 180 ft. wide will be built. This will afford 90,520 sq.ft. covered space for general cargo. The open pier area will have an available storage space of 215,520 sq.ft. The pier is scheduled for completion in October, 1930.

Personal Notes

H. F. Clemmer, who has been technical adviser for the Solvay Process Co., has resigned that position to become engineer of tests and materials with the engineer department of the District of Columbia.

Mortimer Cooley, dean emeritus of the college of engineering, University of Michigan, has been voted honorary membership in the Franklin Institute, of Philadelphia.

Frederick S. Skinner, major, Corps of Engineers, U. S. Army, in charge of the Providence district, North Atlantic Division, has resigned and will retire to private life about Aug. 1. Before being stationed at Providence, Major Skinner was in charge of the Milwaukee district.

E. A. Kingsley has been appointed full-time special consulting engineer of Oklahoma City, Okla. Mr. Kingsley was formerly city engineer of Dallas, Tex., and Little Rock, Ark., and at one time was Arkansas state highway engineer.

L. Alfred Jenny, civil engineer and specialist in railway engineering and allied fields, has become associated with Eppler, Botz & Sangster, accountants and engineers, New York City. Mr. Jenny, while in the employ of the New York Central Railroad, was in charge of the terminal track work and yards of the Grand Central Terminal in New York City.

Major L. B. Chambers, in charge of operations division, Memphis (Tenn.) Engineer District, has been ordered to Fort Lawton to assume charge of the Sixth Regiment of Engineers and command of the post.

Leonard Howell, city engineer for ten years prior to 1926, has been chosen city manager of Ironton, Ohio, replacing E. W. Fassett, who was removed by the city council.

G. Hunter Sykes, former Arkansas state highway engineer, has located in St. Louis, Mo., and will engage in engineering work.

John A. Hiller, superintendent of the Cincinnati (Ohio) Water-Works, has resigned after 33 years' service, and A. S. Hibbs, assistant superintendent, has been appointed in his place.

Carey Herbert Brown, major, Corps of Engineers, who served as asistant director of public buildings and public parks of Washington, D. C., from July, 1925, until July, 1929, has resigned his commission in the army to accept the appointment of director of improvements in the city of Rochester, N. Y. Since leaving Washington he has been stationed at Fort Leavenworth, Kan.

Chad F. Calhoun, formerly engineer for Fisher-Ross-MacDonald & Kahn, Inc., contractor for the San Gabriel dam, Los Angeles County, Calif., has been made general manager and chief engineer of that firm.

Peter Searie, of Denver, representative of the first district, has been elected chairman of the Colorado Board of Highway Advisers, to succeed B. B. Allen, of Silverton. Frank H. Blair, of Sterling, representative of the seventh district, has been elected vice-chairman.

W. R. Bennett, engineer assistant to J. E. Taussig, president of the Wabash Railway, has been appointed chief engineer of the maintenance-of-way department.

Fred C. Barkhurst, of McConnellsville, has been named a division engineer in the Ohio highway department to succeed R. E. Bischoff, resigned.

O. T. Johnson, Jr., of Los Angeles, Calif., who six months ago was appointed to the board of directors of the Metropolitan Water District, has resigned, to accept appointment as a member of the board of water and power commissioners of Los Angeles.

Homer Althar, of New Philadelphia, Ohio, has been appointed engineer-inspector of the Ohio Department of Highways, succeeding H. P. Chapman, who was recently promoted to be chief engineer of the bureau of construction.

John M. Nagle, of Wharton, Tex., for ten years connected with the state highway department, has been appointed city engineer of Houston, succeeding H. L. Shaw, who died on March 31.

Robert R. Litehiser of Columbus, Ohio, who has been office manager of the Columbus branch of the Portland Cement Association, has been named road test engineer in the Ohio Department of Highways to fill the vacancy caused by the death of A. S. Rea.

Society Calendar

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; annual meeting, Atlantic City, N. J., June 23-27.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; annual convention, Cleveland, Ohio, July 9-11.

NATIONAL SAFETY CONGRESS, Chicago; annual meeting, Pittsburgh, Pa., Sept. 29-Oct. 3.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, Pittsburgh, Pa.; 38th annual meeting, Montreal, Canada, June 26-28.

WORLD POWER CONFERENCE, second plenary meeting, Berlin, Germany, June 16-25. American secretary, O. C. Merrill, Washington, D. C.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS will hold its 24th annual meeting at Moline, Ill., on June 16-19, with field demonstrations of machinery and visits to factory plants. The program includes: "Engineering Research Applied to Agriculture," A. F. Woods, U. S. Department of Agriculture; "Agricultural Engineering Research," R. W. Trullinger, U. S. Department of Agriculture; "The Engineer in Tillage Research," H. B. Walker, California Experiment Station; "Industrial Research," C. F. Kettering, General Motors Corp.; "Industrial Uses for Agricultural Products, Byproducts and Wastes," R. A. Clemen, Armour & Co.; "Influences of Farm Machinery," F. A. Wirt, J. I. Case Co. The college division of the society will have papers on training in agricultural engineering. Raymond Olney, St. Joseph, Mich., is secretary.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS will meet at Minneapolis June 24-27.

ARIZONA GOOD ROADS ASSOCIATION, at its summer meeting in Douglas, appointed a committee to draft an amendment to the state constitution designed to provide oil surfacing within three years of all primary highways in the state. It was also voted to prepare a drastic highway safety code to be presented to the state legislature.

CENTRAL NEW YORK CHAPTER, Am.Soc.C.E., at its annual meeting in Syracuse on May 27 elected as president Henry B. Brewster, of Syracuse.

CENTRAL STATES SEWAGE WORKS ASSOCIATION will hold its annual meeting at Springfield, Ill., June 9 and 10. Secretary, G. H. Radebaugh, Urbana, Ill.

COLORADO CHAPTER of the American Society of Mechanical Engineers recently elected Frank H. Prouty, Prouty Bros. Engineering Co., Denver, president; and Arthur Halliwell, assistant superintendent, General Iron Works Co., of the same city, secretary-treasurer.

MONTCLAIR SOCIETY OF ENGINEERS has elected the following officers: president, Henry A. Lardner, vice-president of the J. G. White Engineering Corp.; vice-president, W. R. Smith; secretary, Edgar K. Wilson; treasurer, Harry Barker.

SAN DIEGO SECTION, Am.Soc.C.E., at its meeting on May 22 was addressed by Capt. Charles T. Leeds, U.S.A., retired, of Los Angeles, on "Harbor Development of the Pacific Coast." Captain Leeds outlined the requirements of port construction and maintenance, and compared different problems of the coast ports.

SMOKE PREVENTION ASSOCIATION will hold its annual meeting at Newark, N. J., June 23 to 26. The secretary is Frank A. Chambers, Chicago.

VIRGINIA WATER AND SEWAGE WORKS ASSOCIATION will hold its second annual convention in Norfolk, Va., June 19-20. The program includes papers on treatment of raw water supplies, on impounding reservoirs and maintenance of watershed areas and on methods of sewage treatment. H. W. Snidow, Richmond, is secretary.

Obituary

William H. Adey, of Cohoes, N. Y., died on May 17 at the age of 58. Mr. Adey had been a civil engineer in the employ of the Delaware & Hudson Co. for 30 years and had charge of some of the company's large construction work.

P. H. Everett, senior highway engineer of the U. S. Bureau of Public Roads, was killed in an automobile accident near Round Rock, Tex., on May 24. His car was overturned at a curve and he died within ten minutes. Mr. Everett was in charge of the Austin (Tex.) office of the bureau and looked after the federal-aid features on state highways. He was 52 years old.

Construction Equipment and Materials

To Celebrate Centennial of Platform Scale

To commemorate the invention of the modern platform scale by Thaddeus Fairbanks in 1830, Fairbanks, Morse & Co., of Chicago, is planning a three-day celebration to be held in St. Johnsbury, Vt., July 4-6. The principal feature of the program will be a historical pageant depicting the evolution of the modern weighing machine and its influence on human welfare and world commerce. There will also be an exhibition of original patent models of scales, borrowed for the occasion from the U. S. Patent Office. The celebration will be sponsored by the Vermont Historical Society, the New England Advisory Council and the Chamber of Commerce. Former President and Mrs. Calvin Coolidge will be guests of honor.

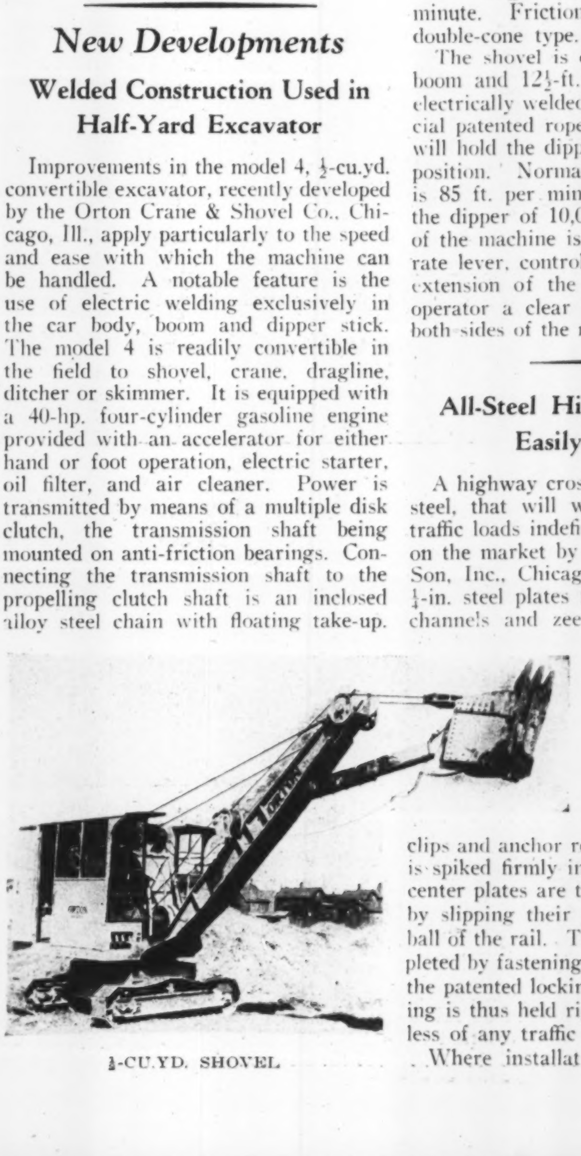
New Developments

Welded Construction Used in Half-Yard Excavator

Improvements in the model 4, ½-cu.yd. convertible excavator, recently developed by the Orton Crane & Shovel Co., Chicago, Ill., apply particularly to the speed and ease with which the machine can be handled. A notable feature is the use of electric welding exclusively in the car body, boom and dipper stick. The model 4 is readily convertible in the field to shovel, crane, dragline, ditcher or skimmer. It is equipped with a 40-hp. four-cylinder gasoline engine provided with an accelerator for either hand or foot operation, electric starter, oil filter, and air cleaner. Power is transmitted by means of a multiple disk clutch, the transmission shaft being mounted on anti-friction bearings. Connecting the transmission shaft to the propelling clutch shaft is an inclosed alloy steel chain with floating take-up. Traveling speeds can be varied from ⅜ to 3 miles per hour. A special main cut-out clutch enables the operator to stop all machinery except the propelling mechanism when traveling.

Crawler treads, of the self-cleaning type, are driven by heat-treated alloy-steel bushed roller chains on hardened sprockets, provision being made for take-up of both the treads and the chains. Coil springs protect the operating mechanism from undue strains and shocks, and distribute the weight of the machine uniformly on uneven ground. Steering is accomplished by brakes applied to either of the two differential shafts, with a special brake provided for holding the machine in position while digging. Power shafts are made of heat-treated chrome alloy steel, and all high-speed gears have cut teeth with wide faces. The main hoisting drum has a single line speed of 160 ft. per minute. Friction clutches are of the double-cone type.

The shovel is equipped with a 16-ft. boom and 12½-ft. dipper stick, both of electrically welded construction. A special patented rope crowd is used which will hold the dipper in a fully extended position. Normal speed of the crowd is 85 ft. per minute, with a thrust on the dipper of 10,000 lb. Each function of the machine is controlled by a separate lever, control being centered in an extension of the cab which gives the operator a clear view of the work on both sides of the machine.

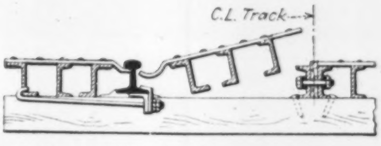


½-CU.YD. SHOVEL

All-Steel Highway Crossing Easily Installed

A highway crossing, made entirely of steel, that will withstand the heaviest traffic loads indefinitely has been placed on the market by Joseph T. Ryerson & Son, Inc., Chicago, Ill. It is made of ¼-in. steel plates firmly riveted to steel channels and zees. A feature of the all-steel crossing is the ease with which it is installed. First the outer plates are secured by placing the ends under the ball of the rail, and locking them to the rail by means of rail clips and anchor rods. The center beam is spiked firmly into the ties. The two center plates are then placed in position by slipping their flangeways under the ball of the rail. The installation is completed by fastening the center plates with the patented locking device. The crossing is thus held rigidly in place regardless of any traffic strain.

Where installation requires the two rails to be electrically insulated from each other, two rolled-steel channels are bolted together with a 1-in. creosoted wood strip in between. The bolts are provided with fiber bushings and washers. These bolted channels are then spiked midway between the rails in place of the center I-beam. The ends of the crossing are bent downward to the ground to prevent dangling chains or air hose from catching in the crossing. Ample circulation of air insures against rotting of the ties.



SECTION OF ALL-STEEL ROAD-RAIL CROSSING

Compound Controls Setting Time of Portland Cement

Remarkable qualities are claimed for a waterproofing compound designed for use with portland cement concrete or mortar which is now being introduced into this country from abroad by the American Sika Corp., New York City. It is stated that this compound has a successful record of seventeen years of use under the most difficult conditions in various foreign countries and that it has been used in waterproofing Welsh coal mines against pressures as high as 600 lb. per square inch.

Sika is used with cement in four different forms, all liquid mixtures of various colloidal solutions of light metals. When used with standard portland cement, the following properties are claimed: complete control of setting time from a minimum of 30 seconds up to normal; greater adhesion to roughened surfaces, including cement, stone, steel and iron; greater strength at all ages; greater density; less shrinkage; and complete resistance to the action of fresh or salt water, acids or oils. The material works by means of a chemical reaction with the cement, this reaction making the lime particles insoluble.

Of the various grades of Sika, probably the most spectacular is No. 2, which sets in 30 seconds and is used in plugging up holes through which water is gushing. Neat cement briquets made with this material have been tested, with strengths exceeding 100 lb. per square inch at one hour and 4,000 lb. per square inch in 24 hours after the time of mixing. Sika No. 4 and 4A are somewhat less rapid, the cement reaching final set in approximately 30 minutes. They are used in running water or to seal against water infiltrations where pressure cannot be relieved but where conditions are not sufficiently severe to require the use of No. 2. The usual method of procedure, under conditions of severe infiltration, is to open one or two holes through which the water can flow easily, coat the major portion of the wall with either No. 4 or No. 4A, and, finally, to seal the holes with No. 2. Usually these cements are employed in relatively thin layers, and are reinforced, after the flow has been shut off, by a heavier coat of cement or mortar mixed with Sika No. 1, which has a normal setting time and is simply a waterproofing agent.

In addition to the varieties already described, there is a Sika No. 5, distributed in the form of a gray paste which is converted into a liquid by adding hot water. This is used for waterproofing porous cement or lime plaster, natural or artificial stone or brick work. It is applied hot and cannot be used except under dry conditions. The application is almost invisible, but leaves a faint deposit on the surface which disappears in time. When desired, this solution may be colored to any required tint, which is often done to give an aged appearance to new brick or tile.

Simple Valve Controls Flow of Compressed Air

A new application of the bypass principle is incorporated in the Quick-As-Wink shut-off valve and coupling recently announced by C. B. Hunt & Son, Salem, Ohio. A $\frac{1}{4}$-in. push or pull on the outer member is the only movement required to turn the flow of air on or off. In combination with Quick-As-Wink couplings, this new valve allows air to be shut off anywhere on the hose line, automatically bleeding air for removal of tools for repairs or oiling. Reference to the diagrams shows how the movable valve sleeve either forms a bypass, admitting air to the tool, or shuts off the supply completely, at the same time releasing pressure in the tool. Quick-As-Wink valves and couplings are made in all sizes from $\frac{1}{8}$ to 4 in. and to fit all common types of hose or pipe connections.

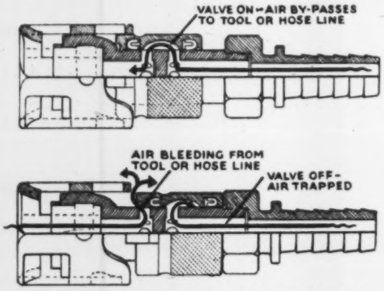
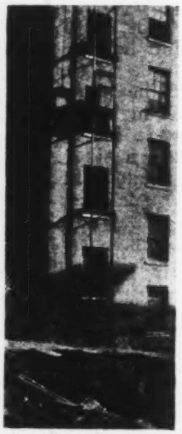

VALVE ON—AIR BY-PASSES TO TOOL OR HOSE LINE
AIR BLEEDING FROM TOOL OR HOSE LINE
VALVE OFF-AIR TRAPPED

DIAGRAM SHOWING ACTION OF VALVE COUPLING

Light Building Hoist Saves Time

Developed particularly for plastering contractors, the Knickerbocker Materialift, an easily erected rig for hoisting relatively small loads in building construction, is equally adaptable to other trades which desire freedom from the delays and congestion incident to sharing hoists with other contractors. The Materialift consists of a bucket of two-barrow capacity, steel guide tees erected in sections, a cathead, a cable and hoist, and an automatic tripping device for dumping the bucket at the desired floor. It is easily erected to any height desired and may be placed either outside the building or in a shaft on the interior. The minimum opening required is 3 ft. 9 in. square. The Materialift is manufactured by the Knickerbocker Co., Jackson, Mich.



LIGHT HOIST

New Publications

Steel Joists—Macomber Steel Co., Canton, Ohio, has issued a simplified loading table to aid the designer in the proper selection of Massillon bar joists. Standard sizes of the Steel Joist Institute are used in the table.

Conveying Apparatus—Standard installations of industrial conveying machinery, including belts and chain conveyors of the gravity and power-driven type, are described in a recent bulletin of the Norfolk Iron Co., Quincy, Mass.

Precast Concrete Building Material—Tee-Stone precast concrete units in standard and special sizes and shapes are described in a recent bulletin of the Public Works Engineering Corp., New York City.

Drag Shovel Attachments and Buckets—Recent bulletins issued by the Page Engineering Co., Chicago, Ill., describe the Page tubular drag shovel attachments, now available for use with about twenty different makes and models of excavators, and buckets ranging in size from $\frac{3}{8}$- to 10-cu.yd. capacity.

Pneumatic Water Systems—Bulletin 111 of the Chicago Pump Co., Chicago, Ill., gives a large amount of data on pneumatic water-supply systems, including a history of the development of such systems, an explanation of the special equipment used, assembly and layout suggestions, and engineering tables and specifications.

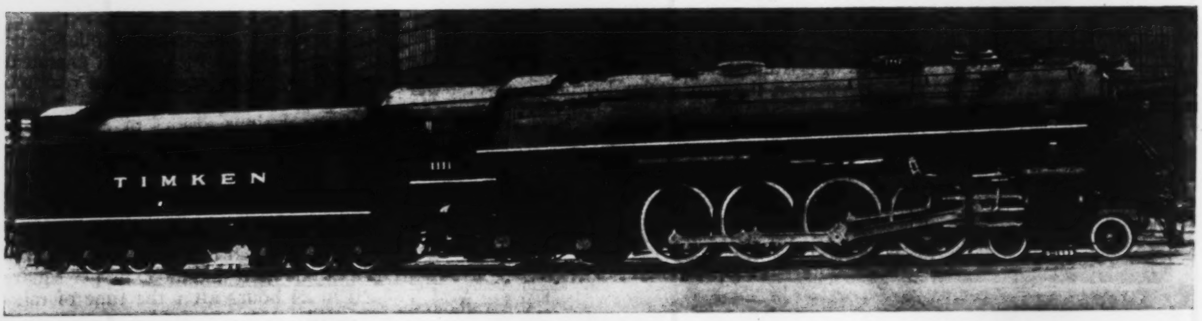
Concrete Admixtures—Master Builders Co., Cleveland, Ohio, has issued a series of four folders giving data and specifications for hardening, dustproofing, waterproofing, dampproofing and coloring concrete.

Dredges—Bulletin P3 of the American Manganese Steel Co., Chicago, Heights, Ill., describes a 10-in. electric hydraulic dredge of unusual design recently placed in use by the Columbus Gravel Co., Columbus, Miss.

Bituminous Paving—Step-by-step pictures showing the method of laying mixed-in-place Tarmac pavement are given in a recent booklet of the American Tar Products Co., Pittsburgh, Pa.

Sewage Pumps—Vortex Sureflo horizontal and vertical sewage pumps for use in sewage-pumping stations, disposal plants, leather factories and for other industrial uses are described in bulletin D-35 of the Lawrence Pump & Engine Co., Lawrence, Mass.

Electrical Apparatus—Recent publications of the General Electric Co., Schenectady, N. Y., include bulletins entitled "Turbines for Waterworks," "Arc Welding in Industry," and "Architecture of the Night," the latter on the subject of floodlighting for buildings. Separate leaflets describing individual pieces of equipment have been issued on capacitor motors, solid-shaft vertical induction motors, inclosed starting rheostats, welding heads and controls, centrifugal compressors, Fabroil and Textolite gears, and strip heaters.



ROLLER-BEARING-EQUIPPED LOCOMOTIVE BEGINS TWO-YEAR TEST

To obtain complete and accurate data on roller-bearing performance under every variety of operating conditions, this locomotive, built by the American Locomotive Co. and equipped with Timken bearings on the main drivers, engine trucks, trailer trucks and tender trucks, as well as on the crankshaft and idler gear of the booster, has recently started a two-year trial period during which it will be used in actual service on a number of American railroads. The locomotive is designed for both passenger and high-speed freight service, and has a total length, with tender, of 102 ft. and a total weight of 711,500 lb. It has a maximum speed of 85 miles per hour and operates on alternative steam pressures of 250 or 235 lb. Due to the variation in weight limitations on different roads, the weight on the drivers is adjustable, hence there are two tractive effort ratings: 76,500 lb. at 250 lb. pressure and 71,900 lb. at 235 lb. Another unusual feature of the machine is the use of alloy steel parts, which has effected a weight reduction in the reciprocating parts of 460 lb. on each side.

The Business Side of Construction

Present Contract Lettings Close to Last Year's Values

THE most significant feature of this year's construction is the strong increase since the middle of March. The January and February figures were 43 per cent behind those of the first two months of 1929. The March, April and May figures are only 3.5 per cent below those of a year ago. This is particularly remarkable as a direct comparison with the heaviest engineering-construction year on record. The first five months of 1929 accumulated a contract total 31.5 per cent greater than that of 1928—previous record year.

Contracts reported in May amounted to 89 per cent of the value of those of May, 1929, and the value for the first five months of this year is 81 per cent of that of the first five months of 1929. The weekly rate for May was 83.5 millions, compared with 76 in April and an average of 70.5 millions for the five months.

Public Works Active

The public-works division, in which highways are such an important part, continue to be much more active than private construction, of which buildings are the dominating structures. May recorded gains over a year ago in waterworks, unclassified, and streets and roads. The cumulative figures for these three classes also are considerably higher than those for the first five months of last year. Bridge lettings in May amounted to 68 per cent of those of May, 1929, and for the five months were 88 per cent. Sewers were 84 and 95 per cent, for the respective periods; federal government, 33 and 100 per cent. Heavy early lettings of highways and streets continue. The value of public buildings for the five months is exactly that of a year ago, but May showed a gain of 13 per cent. Both industrial buildings and other buildings are 30 to 40 per cent under the figures of a year ago.

Activity is strongest this year east of the Mississippi and north of the Mason and Dixon line. The New England and Middle Atlantic states record almost exactly the same contract values this year as last year. The Middle West is 32 per cent under a year ago, due chiefly to a heavy drop in Illinois and Michigan. The western half of the country is 31 per cent behind last year. The South dropped 43 per cent.

Geographical Division of Contracts

The geographical distribution in the month of May shows the same characteristics as do the cumulative figures. The New England and Middle Atlantic states are well above last year's figures. The Middle West is 13 per cent below; Mississippi to Coast, 30 per cent; Southern contracts total only $18,000,000, compared with $75,000,000. Every section of the country reports active public lettings except the South, where they amount to half the value of a year ago.

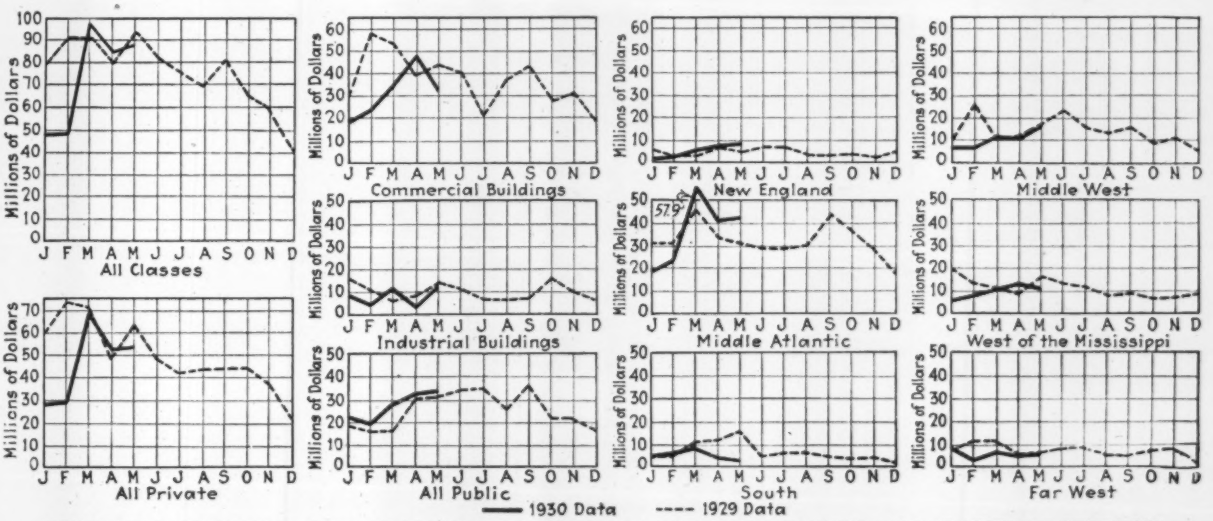
The average monthly value of contracts for all of 1929 was 298 millions; for the first five months of that year, 381, compared with 310 this year.

VALUE OF CONTRACTS AWARDED IN THE UNITED STATES AND TOTAL FOR CANADA, MAY, 1930

Thousands of Dollars (000 omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States			Canada, May, 1930
							May, 1930	Jan. 1-June 1		
								1930	1929	
Water-works	$372	$1,241	$254	$1,778	$1,644	$540	$5,829	$22,348	$18,795	$528
Sewers	614	2,935	1,047	3,679	342	1,207	9,824	34,481	36,466	669
Bridges, private		50					50	5,422	26,853	
Bridges, public	314	5,406	670	2,447	3,847	1,760	14,444	47,859	33,980	426
Excavations	231	39	117	137	9	38	571	8,351	16,021	337
Streets and roads	5,824	29,566	6,651	19,732	14,924	5,924	82,621	242,960	183,462	3,598
Industrial buildings	3,762	25,557	2,440	10,539	1,665	1,861	45,824	171,063	265,572	3,600
Commercial buildings	6,050	69,605	3,970	23,231	8,186	16,197	127,239	516,371	846,096	3,712
Public buildings	6,304	10,333	466	9,180	1,347	2,852	30,482	134,450	133,952	425
Federal government	186	437	113	1,030	722	472	2,960	44,733	44,680	
Unclassified, private	20,175	25,433	1,100	6,186	19,249	872	73,015	254,875	253,624	844
Unclassified, public	211	23,130	111	86	259	441	24,238	65,730	50,259	2,573
May, 1930, 5 weeks	44,043	193,732	16,939	78,025	52,194	32,164	417,097			16,712
April, 1930, 4 weeks	25,200	*137,648	19,748	50,200	47,804	24,789	*305,389			11,448
May, 1929, 5 weeks	25,054	161,695	75,562	90,251	84,773	34,274	471,609			16,992
Jan. 1-June 1, 1930	105,383	754,365	112,799	228,146	206,197	141,753		1,548,643		73,793
Jan. 1-June 1, 1929	102,618	764,051	198,584	339,816	314,089	190,602			1,909,760	72,274

*Revised.



CONTRACTS AWARDED—AVERAGE WEEK PER MONTH—TOTAL U. S. BY CLASSES—ALL CLASSES BY SECTIONS

Financing This Year

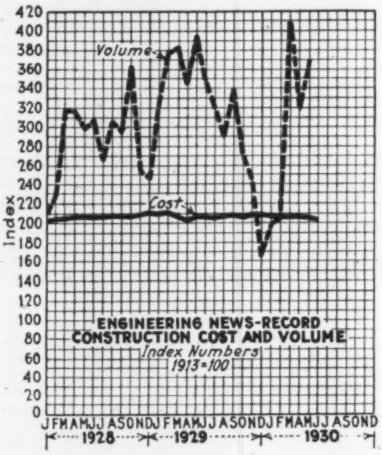
New capital issued for constructive purposes during the first four months of this year is 11 per cent greater in value than for the same period of 1929. This is the result of strong financing by railroads and other public utilities, by oil companies, and by the manufacturers of equipment. There has been a distinct slowing down in industrial financing, including iron and steel, motors and accessories, rubber, shipping, land and buildings.

The April total for corporation financing was $555,000,000, compared with $400,000,000 in April, 1929, a gain of 39 per cent. By far the largest increase was in long-term bonds for railroads. The turn from stock issues to bonds continues. Public-utility bonds totaled $77,000,000, compared with $33,000,000 in April, 1929.

This continues to be a good year for public financing, and the total is 41 per cent larger than for the four months of 1929 and 4 per cent smaller than for 1928. The April total is $147,000,000, compared with $91,000,000 the year before, and is the largest of the last five years. Among 27 issues exceeding $1,000,000 was one of $31,550,000 New York State long-term 4s, maturing 1931-55, awarded to J. P. Morgan & Co. at 102.077, on a basis of 3.79 per cent. The last similar issue was in March, 1928, for $22,500,000 on a basis of 3.69 per cent. The second largest long-term municipal award was $10,000,000 Missouri 4¼s for roads, awarded to a syndicate managed by the Harris Trust and Savings Bank, Chicago, at 100.5737, on a basis of 4.18 per cent. The average price of the 88 April issues was 101.016 and the basis was 4.48.

Construction Cost and Volume Index Numbers

A 10c. drop in the price of steel shapes in the last week of May lowered the Cost Index 1.2 per cent, to 203.36 on June 1. The Volume Index reflects a gain in May lettings over April. The April number has been revised to read 320 instead of 351. These were below the volume of a year ago. The figure is 354, compared with 320 for April and 395 for May, 1929.



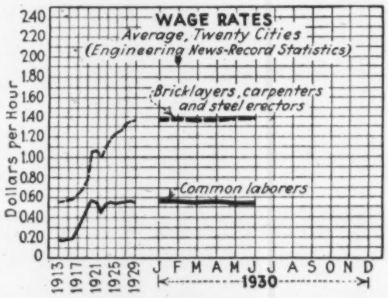
E. N.-R. Cost		**E. N.-R. Volume***	
June, 1930	**203.36**	**May, 1930**	**354**
May, 1930	205.86	April, 1930	†320
June, 1929	205.65	May, 1929	395
Peak, June, 1930	273.80	1929 (average)	317
1929 (average)	207.02	1928 (average)	287
1913 (average)	100.00		
1929		1929	
January	209.40	January	325
February	210.40	February	378
March	207.78	March	382
April	203.40	April	332
May	205.15	May	395
June	205.65	June	347
July	204.77	July	320
August	205.91	August	290
September	207.57	September	340
October	206.32	October	273
November	208.46	November	245
December	209.46	December	166
1930		1930	
January	208.96	January	199
February	206.46	February	204
March	206.80	March	408
April	207.12	April	†320
May	205.86	May	354

*Corrected for price change since 1913.
†Revised.

Construction Employment a Little Better in May

Employment is unimproved since the last report here. A favorable indication is the small increase over seasonal production of crushed stone for the large highway program under way, of granite, and of the manufacture of construction, electrical and refrigeration equipment. In the construction industry, although heavy operations are in satisfactory volume, general employment remains considerably below last year's level. The drop in building, especially severe in residential, explains this. A 90-day suspension of jurisdictional disputes between members of the National Association of Building Trades Employers and the general presidents of international unions affiliated with the A. F. of L. has been effective for the last six weeks. During this truce it is expected that plans will be perfected for reaching a permanent understanding.

The employers' national headquarters estimates for the entire building industry, including 1,600,000 non-union men, three or four unemployed to one mechanic with a job. The A. F. of L. reports 4 per cent improvement in May, compared with 2.5 per cent last year. Advances were granted certain skilled trades in several cities during May. There were no wage cuts, which contrasts with the 5 per cent reduction at Arizona copper mines and a 10 per cent at Eastern sheet mills.



New York—Some 5,000 bricklayers' helpers affiliated with the A. F. of L. merged last month with 10,000 men of an independent union, thus eliminating jurisdictional disputes. A strike of truckdrivers handling face brick, which started May 1 and continued for eight days, was settled tentatively with a wage increase of $2 per day, to $10 for chauffeurs and $7 for helpers, with no interference to construction.

Albany—Painters accepted advance of 5c., to $1.30, with five-day week, abandoning week's strike, following demand for $1.37½ per hour. Stone masons won strike for advance of $2, to $14, having been out one week.

Plainfield—Hodcarriers lost strike and returned to old scale of $9, having demanded $10.

Summit—Master plumbers declare open shop and refuse the journeymen's demands for an advance of $1.20 per day, to $13.20, on five-day basis. Electrical workers' demands for an increase of $2 per day, to $14, are still under consideration.

Paterson—After unsuccessful wage negotiations, plumbers struck for advance of $1.20, to $13.20, while electricians, who had demanded increase of $1.50, to $14.50, signed a three-year compromise agreement.

Baltimore—Painters struck May 16 for increase of $3.20 per day, to $12, the union claiming Baltimore now has the lowest scale in this trade in the country.

Philadelphia—Some 3,000 painters won 25 per cent increase and a five-day week in summer, with the closed shop, by agreement of May 12, effective in installments beginning Sept. 1, with the final rate of $1.25 per hour Jan. 1, 1932.

Pittsburgh—Strike of building trades threatened on public-school jobs worth $4,000,000 unless one dissenting contractor agrees to the closed shop.

PUBLIC WORKS AND UTILITIES REPORTED IN *ENGINEERING NEWS-RECORD*
(Thousands of Dollars)

	1930					
	Jan.	Feb.	Mar.	April	May	Five Months
Railways	$7,680	$8,784	$6,489	$4,044	$11,944	$38,941
Power and lighting	16,625	1,123	2,190	6,386	6,122	32,446
Gas	1,470	335	161	17,400	400	19,766
Telephone and telegraph	150	1,287	112,241	4,824	11,125	129,627
Elec. power plants	20,456	2,191	27,441	1,500	2,408	53,996
Public utilities	$46,381	$13,720	$148,522	$34,154	$31,999	$274,776
Public works	103,066	78,427	115,674	132,776	170,969	600,912
Grand total	$149,447	$92,147	$264,196	$166,930	$202,968	$875,688
Industrial buildings	18,266	14,026	23,985	17,374	43,416	117,067

Chicago—Ironworkers threaten strike if wage increase of 7½c. per hour, to $1.70, is not granted. The International Brotherhood of Electrical Workers propose assessment on local employers for the maintenance of pension fund for aged or incapacitated, in form of increase in wages of 20c. per hour, to $1.90. Employers claim plan would increase construction costs in a market already far too slack.

Davenport—Painters accept increase of 2½c., to $1.15, having receded from original demand for 12½c.

St. Louis—Led by plasterers, union building mechanics ask six-hour day to reduce unemployment. Employers contend that since only a certain number of men can efficiently be employed at a given task, the shorter day will not greatly relieve unemployment.

Sacramento — Building trades mechanics granted five-day week, effective June 2.

Average Wages—The rate for skilled construction labor is $1.39 per hour, compared with $1.38¼ in May and $1.35¾ in June, 1929. The skilled rate in manufacturing is 66.9c. Average common labor rate is 56.28c. per hour, as in May; June, 1929, rate was 53.4c. In manufacturing the unskilled rate is 49.8c.

CURRENT BUILDING AND CONSTRUCTION TRADES WAGE RATES PER HOUR

Advances since last month are indicated by **heavy type**, declines by *italics*

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor*
Atlanta	$1.25@1.40	$0.60@.70	$0.60@1.00	$0.50	....	$0.75@1.25	$0.25@.35
Baltimore	1.75	1.00@1.10	1.00@1.37½	1.00	$0.65	1.00@1.25	.35
Birmingham	1.50	1.00	1.25	.50	....	1.25	.20@.35
Boston	1.50	1.37½	1.37½	.85	1.27½	1.37½	.45@.80
Cincinnati	1.62½	1.40	1.40	1.00	1.40	1.40	.40@.60
Chicago	1.70	1.62½	1.62½	.97½	1.62½	1.62½	.97½
Cleveland	1.62½	1.37½	1.37½	.87½	1.10	1.50	.40@.87½
Dallas	**1.75**	1.12½	1.25	.35 @ .75	1.25	1.25	.35@.50
Denver	1.50@1.62½	1.25	1.25@1.37½	.87½@1.00	....	1.25	.62½
Detroit	1.56¼	1.00@1.25	1.00@1.10	.90	1.00@1.10	1.00@1.25	.50@.60
Kansas City	1.50	1.25@1.37½	1.25@1.37½	.90	1.25	1.37½	.35@.75
Los Angeles	1.37½	1.00	1.00	.75	.87½	1.12½	.37½@.50
Minneapolis	**1.30**	.90	**.90@1.00**	**.80**	....	1.00@**1.25**	.45@.60
Montreal	1.25	.80	.75	....	.90	1.00	.30@.35
New Orleans	1.50	.90	1.25	.75	.80@1.00	1.25	.30@.40
New York	1.87½	1.65	1.92½	1.18¾	1.10@1.23¾	1.92½	1.03⅛
Philadelphia	1.75	1.50	1.02¼	.70@1.12½	1.00	1.37½@1.50	.40@.50
Pittsburgh	1.70	1.50	1.43¾@1.56¼	1.12½	....	1.50	.40@.80
St. Louis	1.75	1.50	1.60@1.75	1.15@1.25	1.25	1.75	.45@.87½
San Francisco	1.37½	1.12½	1.12½	.87½	1.12½	1.37½	.68¾
Seattle	1.50	1.12½	1.12½@1.25	1.00	1.12½	1.25	.70

*Minimum rates are non-union and for construction other than buildings.

Major Materials Prices Lower

Optimistic talk in the steel trade has not succeeded in maintaining prices. In fact, the most important price reduction of the month was in structural steel, to $1.70 from $1.80. A year ago the price was $1.95. The present price is the lowest since July, 1922, and is only 31c. above the lowest figure quoted in March of that year. Nor has this reduction stimulated buying. The chief buyers are oil companies and the utilities, and pipe is the principal product in demand. Business is brisk also in metal lath, and in roofing material and floor plates for factory repairs. Elsewhere dullness, increasing since May 1, exists, particularly as regards railway materials, plates and sheets. Some sheet mills have cut wages 10 per cent. Contractors are bidding under engineers' estimates, and are pressing the mills for concessions. With the further prospect of curtailment in automobile output and in railroad-equipment buying, the steel industry is depressed.

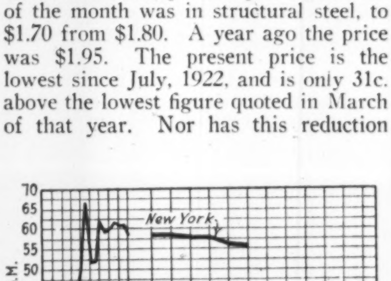
Prices of other materials also tend to decline. Brick deliveries are mostly on orders placed early this spring. With little summer trade in evidence, price cutting is reported in several centers. Cutting thus far has not exceeded $1. The Boston price is down 50c.; Dallas $1.

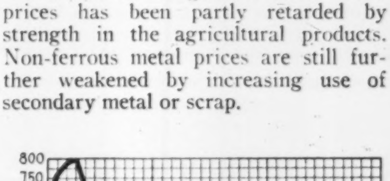
Requirements for lumber are chiefly for small quantities of heavy timbers. Mill shipments, however, are going forward at the usual rate of 200 to 300 million feet per week. New York prices of pine timbers dropped $4, to $20 delivered. Untreated green fir ties are down 17½c. each, to 70c., f.o.b. San Francisco. Fir timber, 8 in., are up to $2.50 per 1,000, to $50 at Denver.

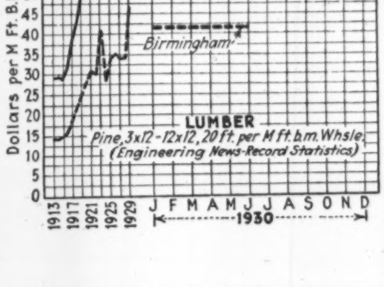
Cement prices at the principal mills have not changed for two months. Dealers' prices were reduced in New York and Atlanta 10-15c. and 15c.

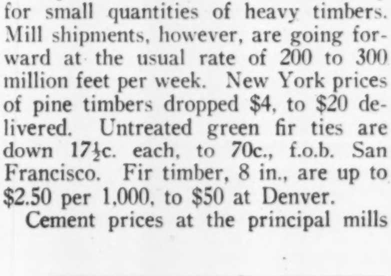
Crushed stone and gravel prices in New York on June 2 were lowered 25c. per cubic yard, to $3.15. Pine ties are down 5c., to $1.05 on 6-in. and $1.20 on 7-in. Prices of wood paving blocks have been reduced 20c., to $2.50 per square yard f.o.b., as a result of too heavy stocks of block lumber in makers' yards.

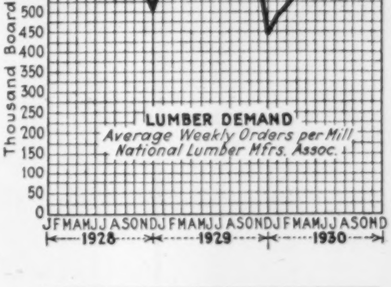
The decline in general commodities prices has been partly retarded by strength in the agricultural products. Non-ferrous metal prices are still further weakened by increasing use of secondary metal or scrap.











CONSUMPTION AND PRICES OF SOME MAJOR BUILDING MATERIALS

Current Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

Building Materials

PORTLAND CEMENT—Prices per barrel, *without charge for bags*, cash discount not deducted. Prices marked f.o.b. are manufacturers'; others are delivered by truck to contractors:

	June 5, 1930	One Mo. Ago	One Yr. Ago
Atlanta	*$2.34*	$2.49	$2.25
Baltimore	2.60	2.60	2.65
Birmingham	2.60	2.60	2.60
Boston	2.50	2.50	2.25@2.35
Dallas	2.15	2.15	2.15
Denver	2.61	2.61	2.55
Jersey City	2.60	2.60	2.25
Kansas City	2.65	2.65	2.55
Los Angeles	1.92	1.92	2.76
Montreal	2.20	2.20	....
New Orleans	2.65	2.65	2.65
New York	*2.15@2.20*	2.30	2.25
Philadelphia	2.10	2.10	2.40
St. Louis	2.45	2.45	2.45
San Francisco	2.64	2.64	2.41
Seattle	2.70	2.70	2.70
(F.O.B.)			
Cedar Rapids	2.23	2.23	2.24
Chicago	1.95	1.95	2.05
Cincinnati	2.14	2.14	2.17
Cleveland	2.04	2.04	2.14
Davenport	2.14	2.14	2.24
Detroit	1.95	1.95	1.95
Duluth	2.04	2.04	2.04
Indianapolis	1.99	1.99	2.09
Milwaukee	2.10	2.10	2.20
Minneapolis	2.27	2.27	2.22
Peoria	2.12	2.12	2.22
Pittsburgh	1.95	1.95	2.05
St. Paul	2.27	2.27	2.22
Toledo	2.20	2.20	2.20

Current mill-prices per barrel, in carloads, without bags, f.o.b.:

Alpena, Mich	$1.65	Limedale, Ind	$1.70
Buffington, Ind	1.70	Mason City, Ia	1.85
Hannibal, Mo	1.80	Norfolk, Va	1.90
Houston, Tex	1.95	North Birmingham, Ala	1.70
Hudson, N. Y	1.85	Richard City, Tenn	2.05
Ironton, Ohio	1.75	Steelton, Minn	1.85
Iola, Kan	1.85	Universal, Pa	1.70
La Salle, Ill	1.80	Wyandotte, Mich	1.70
Lehigh Valley District	1.75		

SAND AND GRAVEL—Per ton, delivered by dealers. Weight of sand per cu.yd., 1½ tons; gravel, 1½ tons, unless otherwise specified in pounds:

	Gravel		Sand
	1½ In.	¾ In.	
Atlanta	$2.60	$2.60	$2.15
Baltimore, per cu.yd	2.40	2.60	1.70
Birmingham, per cu.yd., 2,600 lb	3.50	3.50	3.00
Boston	1.90	1.90	1.25
Chicago, per cu.yd	1.90	1.90	1.80
Cincinnati	1.75	1.75	1.50
Cleveland, per cu.yd., 3,000 lb	2.70	2.70	2.50
Dallas, per cu.yd., 2,700 lb	*2.50*	*2.50*	*2.00*
Denver, per cu.yd., 2,700 lb	1.95	1.95	1.35
Detroit	2.50	1.85	1.65
Kansas City	1.50	1.50	1.35
Los Angeles	1.40	1.40	1.00
Minneapolis, per cu.yd., 2,800 lb	2.40	2.40	1.10
Montreal	1.25	1.25	1.25
New Orleans, per cu.yd., 2,700 lb	3.75	3.75	2.75
New York, per cu.yd	*3.15*	*3.15*	2.15
Philadelphia	2.30@3.15	2.30@3.15	1.50@2.31
Pittsburgh	*1.05*	*1.05*	*1.25*
St. Louis	2.35	2.25	2.00
San Francisco	1.75	1.75	1.75
Seattle, per cu.yd., 3,200 lb	1.75	1.75	1.75

Note: New York gravel weighs 2,800@3,000 lb. and sand, 2,700 lb. per cu.yd.

CRUSHED STONE—Per ton, delivered by dealers. Weight per cu.yd., 1½ tons, unless otherwise specified in pounds:

	1½ In.	¾ In.
Atlanta	$2.60	$2.60
Baltimore, per cu.yd	2.75	2.85
Birmingham, Limestone, per cu.yd	3.00	3.25
Boston	2.10	2.10
Chicago, Limestone, per cu.yd., 2,500 lb	1.90	1.90
Cincinnati	2.25	2.25
Cleveland	2.70	2.70
Dallas, per cu.yd., 2,500 lb	3.25	3.40
Denver, Granite, per cu.yd., 2,700 lb	2.50	2.50
Detroit, Limestone	*2.25*	*2.25*
Kansas City, Limestone	2.60	2.60
Los Angeles	1.50	1.50
Minneapolis, Limestone, per cu.yd., 2,600 lb	2.40	2.40
Montreal	1.90	2.10
New York, Limestone, per cu.yd	*3.15*	*3.15*
Philadelphia, Limestone	2.30@3.15	2.30@3.15
Pittsburgh	2.75	2.75
St. Louis	1.90	1.90
San Francisco, Trap rock	1.65	1.65
Seattle, per cu.yd., 2,700 lb	1.90	1.90

CRUSHED SLAG—Manufacturers' quotation on crushed slag in carloads, per net ton, at plant:

	1½-In.	¾-In.	Roofing	Sand
Birmingham, Ala	$0.90	$1.15	$2.05	$0.55
Buffalo District	1.25	1.35	2.25	1.25
Cleveland, Ohio	1.35	1.35		.80
Eastern Pa. and Northern N. J	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	1.50	1.25
Youngstown District	1.30	1.40	2.00	1.30

HOLLOW TILE—Building tile per block, delivered by dealers to contractors in lots of 2,000 pieces or over:

	4x12x12	6x12x12	8x12x12	10x12x12	12x12x12
Atlanta	$0.069	$0.091	$0.125	$0.157	$0.178
Baltimore	.105	....	.20	....	.26
Birmingham	.09	.127	.174	.218	.261
Boston	.086	.113	.155	.21	.26
Chicago	.076	.104	.142	.182	.202
Cincinnati	**.06815**	*.09485*	.129	.165	.181
Cleveland	.064	.088	.128	.171	.19
Dallas	.094	.112	.179	.251	.296
Denver	.0975	.135	.175	.2125	.25
Detroit	.098	.135	.184	.24	.265
Kansas City	.0525	.077	.184	.24	.265
Los Angeles	.085	.122	.175	.232	.285
Minneapolis	.0611	.081*	.10605	.1302	.1737
Montreal	.12*	......	.22†	....	....
New Orleans	.086	.118	.16	.212	.256
New York	.0864	.1296	.162	....	....
Perth Amboy, N. J. (f.o.b.)	.....	......	......	.2388	.2956
Philadelphia	.105	.14	.215	.28	.34
Pittsburgh	.068	....	.1175	....	.1726
St. Louis	.078	.104	.145	.175	.21
San Francisco	.108	.156	.255	....	....
Seattle	.085	.115	.18	....	....

*4x4x12. †8x8x12.

BRICK—Prices delivered by dealers per thousand, are as follows:

		Paving F.O.B.	
	Common	3x8½x4-In.	3½x8½x4-In.
Atlanta	$12.00	$36.00*	$42.00†
Baltimore	13.00	40.00	46.00
Birmingham	14.00	26.00*	31.00†
Boston	*16.50*	43.00	47.00
Chicago	12.00	42.00	45.00
Cincinnati	17.50	37.00	39.00
Cleveland	14@16	33.00	36.00
Dallas	*13.50*	30.00*	.....
Denver	11.00	.....	.....
Detroit	15.50	33.50	36.50
Kansas City	14.00	.....	.....
Los Angeles	9.00	.....	.....
Minneapolis	12.75	.....	.....
Montreal	20.00	.....	.....
New Orleans	16.50	38.00*	45.00
New York	*13.00*	45.00	50.00
Philadelphia	16.00	40.00	46.00
Pittsburgh	16.00	40.50	45.00
St. Louis	13.50	40.00	40.00
San Francisco	14.50	45.00*	.....
Seattle	14.00	50.00	55.00

*2½x8½x4 in. †3x8½x4.

LIME—Prices delivered by dealers to job:

	Hydrated, per Ton		Lump, per Barrel	
	Finishing	Common	Finishing	Common
Atlanta	$21.00	$13.50	......	......
Baltimore	22.00	14.00	$2.55†	......
Birmingham	22.00	16.00	3.00†	$2.00†
Boston	22.00	15.00	4.00*	3.15*
Chicago	17.00	14.50	15.00‡	15.00‡
Cincinnati	15.80	13.00	......	......
Cleveland	18.00	15.00	2.50†	2.50†
Dallas	20.00	......	......	18.00‡
Denver	32.00	23.75	3.80*	3.00*
Detroit	18.00	14.80	2.20†	2.00†
Kansas City	16.00	12.50	2.85†	2.50†
Los Angeles	18.90	16.00	2.85†	14.00‡
Minneapolis	25.50	21.00	......	1.70†
Montreal	19.75	......	......	15.00‡
New Orleans	......	......	2.60†	1.60†
New York	21.00	14.00	4.10*	3.15*
Philadelphia	22.00	15.00	......	......
Pittsburgh	20.00	*17.00*	*2.20*†	......
St. Louis	24.00	18.00	2.75†	15.00‡
San Francisco	20.00	20.00	2.00†	**1.85**†
Seattle, paper sacks	36.00	24.00	......	2.80†

*Per 280-lb. bbl. (net). †Per 180-lb. (net). ‡Per ton.

CONCRETE BLOCKS—Manufacturers' quotations on standard, 8x8x16-in., hollow, delivered to job, each:

Boston	$0.18@$0.20	Minneapolis	$0.15
Brooklyn and Queens	.12@ .14	New Orleans	.22
Cleveland	.16@ .17	Philadelphia	.18@.25
Denver	.22	Pittsburgh	.20
Detroit	.15	St. Louis	.18

SLATE—Roofing, f.o.b., quarry, Bangor, Pa., net, per square:

No. 1 Clear	$9.45@$13.05
No. 1 Ribbon	8.10@ 9.23
Medium Clear	8.55@ 10.13

Road and Paving Materials

PAVING STONE—Carloads or cargo lots of granite blocks, 4x8x4-in. dressed, f.o.b.:

Atlanta	$3.00 per sq.yd.
Baltimore	3.00 per sq.yd.
Boston	135.00 per M.
Chicago, 5 in	3.25@3.90 per sq.yd.
Cincinnati	110.00 per M.
Cleveland	115@120 per M.
Detroit, 5 in	3.00 per sq.yd.
Kansas City	3.00 per sq.yd.
Minneapolis, 4½x8x5 in	2.80 per sq.yd.
Montreal	104.75 per M.
New Orleans	2.80 per sq.yd.
New York, 5 in., Grade 1, 30 blocks per sq.yd	150.00 per M.
Philadelphia	125.00 per M.
St. Louis, 4x5x8 to 12 in	3.50 per sq.yd.

Current Prices of Construction Materials

Road and Paving Materials—Continued

WOOD-BLOCK PAVING—Prices, f.o.b., in carloads:

	Size of Block	Treatment	Per Sq.Yd.
Atlanta	3½	16	$2.25
Boston	3½	16	2.25
Chicago	3½	12	2.10
Cincinnati	3½	16	2.35
Kansas City	3½	16	2.75
Minneapolis	3½	16	2.75
Montreal	4	16	4.50
New Orleans	3½	16	2.40
New York	3½	16	*2.50*
St. Louis	3½	16	2.40

FLAGGING—Alongside dock, New York: Manhattan and Bronx, 4 ft. wide, 24c. per sq.ft.; Queens, 5 ft. wide, 26c. per sq.ft.

CURBING—*New York*: Bluestone, f.o.b. barge, 5x16 in., rough, 90c. per lin.ft., cutting charges extra. *Birmingham*: Limestone, 5x18-in., f.o.b., $1.05 per lin.ft. *St. Louis*: Class "B" straight, 5x16-in., f.o.b., $1.00 per lin.ft.; roundings, $1.35 per lin.ft.

ASPHALT—Manufacturers' quotations per ton in packages (350-lb. bbls or 425-lb. drums); also in tank-car lots, f.o.b. points listed:

	Package	Tank-car
Atlanta (Mexican)	$20.40	$16.40
Baltimore (Standard Oil, f.o.b. refinery)	21.75	17.75
Birmingham (Mexican)	27.00	23.00
Boston (Mexican)	23.50	18.00
Chicago (Texas)	23.50	19.30
Cincinnati (Kentucky Rock)	......	12.30
Cleveland	24.00	20.00
Dallas (Texas)	*24.30*	......
Denver (California)	35.00	......
Detroit (Mexican) (Texas)	19.72	14.87
Kansas City, Mo. (Texas)	23.50	17.00
Los Angeles ("D" Grade, Calif., f.o.b., El Segundo)	18.00	12.00
Maurer, N. J. (Bermudez)	30.00	......
Maurer, N. J. (Trinidad)	25.00	......
Minneapolis, (Stanolind, f.o.b., Twin Cities)	23.00	19.10
Montreal (Imperial)	28.00	21.50
New Orleans (Texas)	24.00	21.00
New York (Texas)	22.50	18.50
Philadelphia (Mexican)	18.00	15.00
Pittsburgh (Standard Oil)	24@26	14@18
St. Louis (Venezuela)	22.50	18.50
San Francisco, (f.o.b. refinery, Oleum, Calif.)	18.00	12.00
Seattle, ("D" grade, Calif., f.o.b. Richmond)	18.00	12.00

ROAD OILS—Manufacturers' quotations, f.o.b., in tank cars, 8,000 gal. minimum, per gal.:

Birmingham, 40@50% asphalt	$0.0525
Birmingham, 50@60% asphalt	.0525
Dallas, 40@50% asphalt	.055
Dallas, 50@60% asphalt	.055
New York, 40@50% asphalt, (at terminal)	.05
New York, 50@60% asphalt, (at terminal)	.05
St. Louis, 40@50% asphalt	.04
St. Louis, 50@60% asphalt	.04

Iron and Steel

PIG IRON—Producers' quotations, per gross ton, f.o.b.:

Birmingham, No. fdry., silicon 1.75@2.25	*$14.00*
Pittsburgh, basic, incl. freight ($1.76) from Valley	*19.63@20.13*

STRUCTURAL STEEL—Manufacturers' and dealers' quotations per 100 lb.

	Shapes, 3 to 15-In.	Plates, ¼-In.
Birmingham, large mill lots, f.o.b	$2.15	$2.15
Chicago, warehouse, delivered	3.10	3.10
Cleveland, warehouse, delivered	3.00	3.00
Dallas, warehouse, delivered	**3.90**	**3.90**
New York, warehouse, delivered, up to 3,999 lb.	3.30	3.30
Pittsburgh, large mill lots, f.o.b	*1.70*	*1.70*
St. Louis, warehouse, delivered	3.25	3.25
San Francisco, warehouse, delivered	3.40	3.40

BARS, CONCRETE REINFORCING—Manufacturers' and dealers' quotations on bars rolled from billets, per 100 lb. for ¾-in.:

Birmingham, large mill lots, f.o.b	$2.15
Chicago warehouse, delivered	2.15@3.00
Cleveland, warehouse, delivered	2.25@2.44
Dallas, warehouse, delivered	*2.94*
New York, warehouse, delivered, over 5 tons	2.70
Pittsburgh, large mill lots, stock lengths, f.o.b	*1.75*
St. Louis, warehouse, delivered	3.15
San Francisco, warehouse, delivered	2.25

EXPANDED METAL LATH—Per 100 sq.yd., painted, delivered to job, in less-than-carload lots:

Lb. per Sq.Yd.	New York	Birmingham	Chicago	St. Louis	Dallas	San-Francisco
2.2	$18.50	$22.00	$16.00	$18.00	*$21.00*	$21.50
2.5	19.50	23.00	17.00	19.00	24.00	22.50
3.0	21.00	25.00	18.50	20.50	25.50	25.00
3.4	22.00	26.50	19.50	21.50	*28.60*	27.00

WIRE REINFORCEMENT FOR CONCRETE—Manufacturers' quotations per 100 sq.ft. in carloads at mills; and delivered by dealers, in lots of 10,000 sq.ft. or over; plain 4 in. by 4 in. mesh:

				Warehouse Delivery			
Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	New York	St. Louis	Dallas	San Francisco
032	22	$0.99	$1.01	$1.39	$1.45	$1.13	$1.22
049	28	1.26	1.29	1.76	1.80	1.38	1.55
068	35	1.54	1.58	2.18	2.25	1.67	1.91
093	40	1.98	2.03	2.79	2.90	2.00	2.46
126	57	2.45	2.51	3.45	3.55	2.55	3.03
153	68	2.92	2.99	4.13	4.25	3.15	....
180	78	3.35	3.43	4.73	4.85	3.47	....

STEEL SHEETS—Manufacturers' and dealers' quotations per 100 lb. base:

	Blue Annealed No. 10*	Black No. 24	Galvanized No. 24
Chicago, warehouse, delivered	$3.35†	$4.05†	$4.60†
Cleveland, warehouse, delivered	3.25	3.75	4.50
New York, warehouse, delivered	3.50@3.60†	3.65@3.90	4.25@4.50
Pittsburgh, large mill lots, f.o.b	*1.90@*2.10	2.55@2.65	3.30
St. Louis, warehouse, delivered	3.45	4.25	4.85
San Francisco, warehouse, delivered	*3.80*	*4.35*	*5.00*

*Light plates. †400 lb. to 3,999 lb.

WIRE ROPE—Discounts from manufacturers' list price on regular grades of bright and galvanized, Eastern Territory, New York, and East of Missouri River:

	Base
Cast steel round strand rope	20%
Galvanized iron rigging and guy rope (add to list)	12½%
Galvanized steel rigging and guy rope	7½%
Plow steel round strand rope	35%
Round strand iron and iron tiller	5%
"Special Steel" and extra strong cast steel, round strand rope	27½%

Discount 5 points less than discount for Eastern territory: California, Oregon, Nevada, Washington, Wyoming, New Mexico, Colorado, North Dakota, Nebraska, Kansas, Oklahoma and Texas. Discount 10 points less than discount for Eastern territory: Arizona, Montana, Idaho and Utah.

RIVETS—Manufacturers' and dealers' quotations on structural rivets, round-head, ¾-in., full kegs, per 100 lb.:

Chicago, warehouse, delivered	$4.00
Dallas, warehouse, delivered	4.50
New York, warehouse, delivered	4.50*
Pittsburgh, large mill lots, f.o.b	*2.90*
St. Louis, warehouse, delivered	4.15
San Francisco, warehouse, delivered	**5.50**
Seattle, warehouse, delivered	4.25

*This price is for full kegs; broken kegs are $6.00 per 100 lb.

STEEL SHEETPILING—The manufacturers' base price, f.o.b., Pittsburgh, for large mill lots is $2.25 per 100 lb.

TERNE PLATE—I C, 8-lb. coating, 20x28-in., f.o.b., Pittsburgh mill:

Per package	$10.70

SHIP SPIKES—Per 100 lb., black, from dealers' warehouse stocks; galvanized are about $1.75 per 100 lb. higher:

	¼-In.	⅜-In.	½-In.
San Francisco	$5.55	$5.10	$4.95
Seattle	7.75	5.65	5.50

Pittsburgh mill base in lots of 200 kegs or more, $3.00 per 100 lb.

WIRE NAILS—Per 100 lb. keg, base, delivered from warehouse stocks; also Pittsburgh mill base:

Pittsburgh Mill	Birmingham	Chicago	St. Louis	Dallas	San Francisco	Montreal
$2.30@$2.40	$3.30	$2.75@$2.85	$2.85	$3.75	$3.25	$4.95

SCRAP—The prices following are, f.o.b., per ton, paid by dealers:

	New York Per Gross Ton	Chicago Per Gross Ton	Detroit Per Gross Ton
No. 1 railroad wrought	*$10.00@$10.50*	*$12.50@$13.00*	*$11.50*
Stove plate	*6.50@ 8.50*	*10.50@ 11.00*	*9.00*
No. 1 machinery cast	*10.25*	14.00@ 14.50	*11.00**
Machine shop turnings	*5.50@ 6.00*	*7.00@ 7.50*	*7.00*
Cast borings	*6.50*	*8.50@ 9.00*	*8.00*
Railroad malleable	*10.50@ 11.00*	*15.25@ 15.75*	13.00
Re-rolling rails	*10.00@ 10.50*	*14.75@ 15.25*	13.00
Re-laying rails, 56@60 lb	*23.00*	**23.00**@ 25.00	13.00
Heavy melting steel, No. 1	*9.50@10.50*	*12.50@ 13.00*	*12.00*
Iron and steel pipe	*8.75*	*7.50@ 8.00*	.....

*Net ton.

FREIGHT RATES—Effective May 20, 1930, on finished steel products in the Pittsburgh district, including plates, structural shapes, merchant-steel bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished) chains, etc., the following freight rates in cents per 100 lb., apply on carload lots of 36,000 lb. or 18 tons:

Atlanta	$0.58	Detroit	$0.265
Baltimore	.27	Kansas City	.71†
Birmingham	.58	New Orleans	.67
Boston	.40	New York	.33
Buffalo	.235	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.29
Cincinnati	.265	St. Louis	.39
Cleveland	.185	St. Paul	.60
Denver	1.15*		

*Minimum weight on structurals, 60,000 lb. †Except iron or steel pipe and fittings.

Railway Materials and Supplies

STEEL RAILS—Manufacturers' quotations per gross ton, f.o.b., for large mill lots:

	Pittsburgh	Birmingham	Chicago
Standard openhearth rails	$43.00	$43.00	$43.00
Light rails, 25 to 45 lb	36.00	34@36	34@36
Re-rolled rails	34.00	34@36	34@36

RAILWAY TIES—For fair-sized orders, f.o.b., the following prices per tie hold:

		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
New York	Long-leaf sap pine, untreated	*$1.05*	*$1.20*
	Creosoted—prices on application.		
Birmingham	White oak, creosoted	1.52	1.75
	Southern pine, creosoted	1.25	1.60
Chicago	White oak, untreated	1.40	1.78
	Oak, empty cell, creosoted	1.80	2.40
	Oak, zinc treated	1.60	2.10
	Southern pine, creosoted	1.60	2.10
St. Louis	White oak, untreated	1.05	1.50
	Red oak, creosoted	1.40	1.90
	Sap pine or cypress, untreated	.85	1.20
San Francisco	Douglas fir, green, untreated	*.70*	*1.06*
	Douglas fir, empty cell, creosoted	*1.54*	2.38
Montreal	Birch or maple, untreated	.75@1.25	.75@1.25
	Birch or maple, creosoted	1.20@1.30	1.50@1.60

Current Prices of Construction Materials

Railway Supplies—Continued

TRACK SUPPLIES—Manufacturers' and dealers' quotations per 100 lb. f.o.b., Pittsburgh mill, for large mill lots, together with warehouse prices at other places named:

	Pittsburgh	Chicago	Birmingham	St. Louis	San Francisco
Standard spikes, 9/16-in. and larger	$2.80	$3.55	$3.45	$3.75@$3.85	*$4.00*
Track bolts	3.80@4.00	4.55	5.85	4.85@ 4.95	*5.00*
Standard section angle bars, splice bars or fish plates	2.75	3.40	3.75	....	.....

Tie plates: Price at Pittsburgh mill, $2.07½ per 100 lb.

Pipe

WROUGHT-STEEL PIPE—Discounts from manufacturers' and dealers' standard lists:

	1 to 3-In. Butt Weld		3½ to 6-In. Lap Weld	
	Black	Galvanized	Black	Galvanized
Chicago, warehouse, delivered	57.3%	44.8%	53.9%	41.4%
Cleveland, warehouse, delivered	53.3%	42.3%	50.8%	37.8%
New York, warehouse, delivered	56.02%	43.48%	52.6%	40.06%
Pittsburgh, large mill lots, f.o.b.	64%	52.5%	61%	49.5%
St. Louis, warehouse, delivered	49%	36%	46%	33%

CAST-IRON PIPE—Prices of U. S. Pipe & Foundry Co., per net ton, for bell and spigot pipe, Class B and heavier, f.o.b., on regular lots of pipe:

	4-In.	6-In. and Over
Birmingham mill	$40.00@$41.00	$37.00@$38.00
Burlington (N. J.) mill	40.00	37.00
Chicago	48.20@ 49.20	45.20@ 46.20
New York	42.90	39.90
Pittsburgh	48.80@ 49.80	45.80@ 46.80
St. Louis	47.00@ 48.00	44.00@ 45.00
San Francisco	50.00@ 51.00	47.00@ 48.00

Gas pipe and Class A, $3.00 per ton extra.

SEWER PIPE—Prices delivered, per foot, for standard pipe; 6, 8 and 12-in. are single strength and 18, 24, 30 and 36-in. are double strength:

	6-In.	8-In.	12-In.	18-In.	24-In.	30-In.	36-In.
Atlanta	$0.16	$0.26	$0.46	.....	.....	.....	.....
Baltimore	.10	.30	.58	.....	$1.93	.....	$6.50
Birmingham	.25	.40	.65	$1.50	2.75	$3.90	5.83
Boston	.185	.30	.555	1.35	2.25	3.70	6.50
Chicago	.18	.28	.54	1.25	2.25	4.75	6.00
Cincinnati	.135	.21	.405	1.05	1.89	3.456	5.4325
Cleveland	.189	.294	.567	1.35	2.43	4.824	7.38
Dallas	.25	**.395**	.68	1.60	2.85	.....	.....
Denver	.161	.23	.414	.816	1.44	.....	.....
Detroit	.18	.28	.6075	1.50	2.70	5.12	7.91
Kansas City	.21	.29	.52	.....	1.90	3.80	.....
Los Angeles	.21	.2825	.51	1.186	2.03	3.39	5.09
Minneapolis	.16	.25	.50	1.15	1.85	3.49	4.97
Montreal	.36	.53	.78	1.48	2.75	4.20	.....
New Orleans	.195	.325	.585	1.10	2.11	.....	.....
New York	.185	.29	.56	1.35	2.45	4.60	7.07
Philadelphia	.117	.182	.351	1.05	1.89	3.60	5.6375
Pittsburgh	.0945	.147	.2835	.85	1.53	3.024	4.8175
St. Louis	.1645	.26	.468	1.092	1.872	3.65	4.80
San Francisco	.1925	.275	.495	1.155	1.98	3.30	4.95
Seattle	.22	.30	.54	1.26	2.16	3.50	.....

CLAY DRAIN TILE—Prices delivered by dealers, per 1,000 lin.ft.:

Size, In.	New York	Birm'ham	St. Louis	Dallas	San Fran.	Seattle
4	$55.00	$56.00	$50.00	$63.00	$67.50	$60.00
6	112.00	112.00	85.00	110.00	112.50	112.00

Miscellaneous

LINSEED OIL—Raw oil, f.o.b., in 1- to 4-bbl. lots, per lb.:

New York	Chicago	Minneapolis
$0.146	*$0.15*	*$0.155*

WHITE AND RED LEAD—Base price per 100-lb. keg, f.o.b., New York: White, dry, $13.75; White, in oil, $14.25; Red, dry, $13.75; Red, in oil, $15.25.

CHEMICALS—Water, sewage treatment, road work, round lots in the New York market:

Sulphate of aluminum, in bags, per 100 lb	$1.40@$1.45
Sulphate of copper, in bbl., per 100 lb	*4.50@ 5.00*
Soda ash, 58%, in bags, per 100 lb.	1.32@ 1.35
Chlorine, cylinders, per lb	.04½@ .06
Bleaching powder, in drums, f.o.b. works, per 100 lb.	2.00@ 2.10
Calcium chloride, flaked, in drums, f.o.b. works, per ton	22.75

MANILA ROPE—The number of feet per pound for the various sizes is as follows: ⅝-in., 7-ft., 6-in.; ¾-in., 6-ft., 1-in.; ⅞-in., 4-ft., 5-in.; 1-in., 3-ft., 8-in.; 1¼-in., 2-ft., 5-in.; 1½-in., 1-ft., 8-in. Following prices are quoted by dealers per pound for ¾-in. and larger:

Atlanta	$0.25	Kansas City	$0.25
Baltimore	.225	Los Angeles	.25
Birmingham	.26	Minneapolis	*.22*
Boston	.215	Montreal	.185
Chicago	.20	New Orleans	.25
Cincinnati	.21	New York	.205
Cleveland	.21	Philadelphia	.23
Dallas	*.2075*	San Francisco	.205
Denver	.24	Seattle	.215
Detroit	.23	St. Louis	.225

BUILDING PAPER—Black, in carloads, per roll of 500 sq.ft., f.o.b., producing point $2.00

SLATERS FELT—In carloads, per roll, f.o.b., producing point $0.77

ROOFING MATERIALS—Price f.o.b., New York, delivered by dealers to contractors in carloads:

Asphalt felt, per 100 lb.	$2.60
Tar felt, per 100 lb.	2.60
Asphalt coating, per gal.	.34¼
Tar pitch, in 350 lb. barrels, per ton	28.00

PREPARED ROOFINGS—Prices delivered by dealers to contractors, in each load, f.o.b. New York, per square:

Single shingles, slate finish, sufficient to cover 100 sq.ft.	$6.12
Strip shingles, 4 in 1, hexagonal shape, with Underwriters' label	5.00
Slate surfaced roofing in rolls weighing 85 to 90 lbs.	2.50

WINDOW GLASS—United inches 25, bracket size 6x8 to 10x15, single or double thickness, discount from jobbers' list (Sept. 15, 1928), at New York warehouses:

AA	A	B
83%	86%	88%

EXPLOSIVES—Manufacturers' quotations per pound for dynamite delivered in small lots, under 200 lb.:

	Gelatin			Gelatin	
	40%	60%		40%	60%
Atlanta	$0.22	$0.245	Los Angeles, f.o.b.†	$0.1875	$0.2225
Baltimore	.215	.2375	Minneapolis	.2225	.2450
Birmingham	.22	.245	Montreal	.20	.24
Boston	.22	.25	New Orleans	.195	.22
Chicago	.195*	.22*	New York	.255‡	.2775‡
Cincinnati	.22	.245	Philadelphia	.215	.24
Dallas	.1875	.245	St. Louis	.215	.235
Denver, f.o.b.	.19	.2125	San Francisco	.155	.18
Kansas City, Mo.	.2025	.2225	Seattle	.1525	.175

*Quantities above 500 lb. but less than a ton. †San Fernando Arsenal. ‡Special gelatin in case lots.

Lumber

Prices Are Per Thousand Feet, Board Measure

New York—Timbers, No. 1 Common, rough, delivered to contractor at site of job, in 20 ft. lengths and under, per M. ft., b.m.:

	Long-leaf Yellow Pine	Douglas Fir
3x4 to 8x8	*$50.00*	$39.00
3x10 to 10x10	*60.00*	40.00
3x12 to 12x12	*70.00*	42.00
3x14 to 14x14	*80.00*	50.00

Chicago—Prices, f.o.b., in carloads, No. 1 Common, rough per M. ft. b.m For delivery to job from stock, in truckloads, add $10 per M. ft., b.m.:

	20 Ft. and Under Long-Leaf Yellow Pine	Up to 32 Ft. Douglas Fir
3x4 to 8x8	$43.00	$41.00
3x10 to 10x10	50.50	41.00
3x12 to 12x12	62.50	41.00
3x14 to 14x14	74.50	42.00

San Francisco—Douglas fir, No. 1 common, rough, at yards. For delivery to contractor at site of job, add $1.50 to $5 per M. ft., b.m.:

	10-16-18 and 20 Ft.	22 and 24 Ft.
3x3 and 4	$33.00	$36.00
3x6 and 8	33.00	36.00
3x10 and 12	33.00	36.00
3x14	37.00	39.00

Other Cities—Delivered by dealers, No. 1 Common, rough, per M. ft., b.m.:

	8x8-In. x 20 Ft. and Under				3x12 to 12x12-In. 20 Ft. and Under	
	Pine*	Fir†	Hemlock	Spruce	Pine*	Fir†
Atlanta	$55.00	......	......	......	$65.00	......
Baltimore	36.00	$50.00	$53.50	$61.00	75.00	$50.25
Birmingham	53.00	......	......	......	56.50	......
Boston	52.50	45.00	47.00	48.00	60.00	40.00
Cincinnati	47.50	58.50	......	......	65.00	52.50
Cleveland	63.00	63.00	......	......	63.00	63.00
Dallas	55.00	55.00	55.00	55.00	55.00	55.00
Denver	......	**50.00**	47.50	47.50	......	55.00
Detroit	*54.00*	*52.00*	......	......	68.50	*52.00*
Kansas City, Mo.	47.50	57.50	......	......	52.50	55.00
Los Angeles	......	42.50	......	......	......	44.50
Minneapolis	58.00	*50.25*	38.25‡	......	58@60	*50.25-51.75*
Montreal	50.00	48.00	......	......	56.00	48.00
New Orleans	52.00	48.00	......	44.00	67.00	65.00
Philadelphia	50.00	43.00	42.00	48.00	60.00	43.00
Pittsburgh	65.00	70.00	75.00	65.00	65.00	65@72
St. Louis	48.00	43.00	43.00	......	60.00	44.00
Seattle	......	21.00	......	......	......	21@22

	1x10 In. x 16 Ft. and Under			2x10 In. x 16 Ft. T. & Gr.	
	Pine*	Fir†	Hemlock	Pine*	Fir†
Atlanta	$60.00	......	......	$42.50	......
Baltimore	56.00	$45.00	$44.00	......	......
Birmingham	36.00	......	......	45.00	......
Boston	46.00	40.00	42.00	48.50	$45.00
Cincinnati	61.00	52.50	......	38.00	50.00
Cleveland	60.00	55.00	......	65.00	58.00
Dallas	60.00	......	......	55.00	......
Denver	......	38.00	38.50	......	44.00
Detroit	**48.50**	45.00	......	48.50	47.00
Kansas City, Mo.	57.50	57.50	57.50	47.00	48.00
Los Angeles	......	41.50	......	......	55.00
Minneapolis	53.00	*44.00*	39.75‡	51.00	*43.00*
Montreal	56.00	......	......	......	......
New Orleans	49.00	49.00	......	59.00	55.00
Philadelphia	52.00	43.00	41.00	55.00	44.00
Pittsburgh	50.00	60.00	59.00	42.00	......
St. Louis	43.00	42.00	41.00	45.00	42.00
Seattle	......	21.00	......	......	20.00

*Long-leaf yellow pine. †Douglas fir. ‡F.o.b.

PILES—Prices of Nichols Bros., 90 West St., N.Y.C., per lineal foot, pine, with bark on, f.o.b., New York; delivered from barge, 1¾ to 2c. per ft. additional:

Dimensions	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.36
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.31
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.33	.41
14 in.—2 ft. from butt	5 in.	85 to 89 ft.	.38	.45

Unit Prices From Current Construction Bids

Elevated Public Highway Along Hudson River Waterfront in New York City

THE West Side elevated public highway project in Manhattan extends along the Hudson River waterfront from Canal St. to the northerly end of Manhattan Island. Bids for the construction of the footings and steel superstructure on Sec. 1, Div. 1, extending from Canal St. to West 22d St., were opened April 8, 1929, and the contract was awarded to James Stewart & Co., Inc., for $4,547,489. The foundation work has been well advanced and is about 90 per cent completed. The steel erection is about 65 per cent done. A separate contract for the work of completing the structure between the above-mentioned limits, for which bids were received on April 3, 1930, has also been awarded to James Stewart & Co., Inc., for $1,476,585. Included in the latter contract are ramps at Canal St. and West 20th St., for which the bids on a lump sum basis were $235,000 and $137,000 respectively, together amounting to about 25 per cent of the contract price.

The contract just entered into for the completion of the ramps and superstructure involves the placing of 13,000 cu.yd. of concrete in the floorslab and curbs; 484,000 sq.ft. membrane waterproofing; laying 56,000 sq.yd. granite block pavement; placing 3,000,000 lb. reinforcing steel; 326,000 lb. cast iron in expansion joints, splice and pull boxes for conduit and light standard bases and column caps; 37,000 lin.ft. of conduit for lighting, fire alarm and telephone wiring; erection of lighting standards and brackets, fire alarm and telephone posts, traffic signal booths and numerous other items of work required to make the structure complete and ready for traffic.

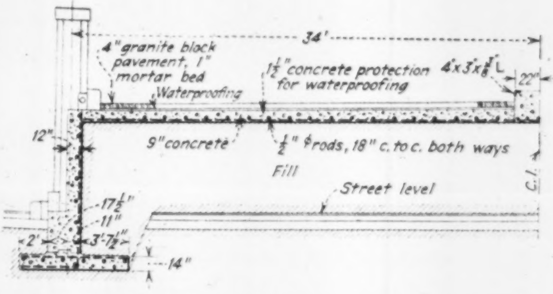

34'
4" granite block pavement, 1" mortar bed
Waterproofing
1½" concrete protection for waterproofing
4"x3"x⅜" L
22"
12"
9" concrete
½" ϕ rods, 18" c. to c. both ways
Fill
Street level
C.L.
17½"
11"
2'
3'-7½"
14"

FIG. 2—TYPICAL HALF-SECTION OF CANAL ST. RAMP WITH CANTILEVER RETAINING WALLS

	A	B	C	D
Completion Canal St. ramp (lump sum)	$235,000.00	$275,000.00	$290,000.00	$322,800.00
Completion 20th St. ramp (lump sum)	137,000.00	143,000.00	160,000.00	182,850.00
13,000 cu.yd. conc. floorslab and curbs	16.25	18.00	18.00	21.00
3,000,000 lb. steel reinf. bars	0.05	0.04	0.055	0.045
5,100 lin.ft. copper gutters	1.37	1.00	1.00	1.05
920 lin.ft. copper leaders	.77	.90	.50	.55
12,200 lin.ft. copper v. flashing	.60	.55	.50	.55
2,500 lin.ft. 1¼-in. drains	1.31	.50	1.00	1.25
160 floorslab drains	2.20	5.00	4.00	5.00
580,000 lb. misc. steel	.086	.09	.10	.08
493,000 lb. checkered plates	.073	.08	.08	.065
141,000 lb. curb exp. joints	.067	.07	.07	.07
60,000 lb. splice-pull boxes	.077	.09	.07	.065
93,000 lb. light standard bases	.074	.07	.08	.085
32,000 lb. interior column caps	.067	.07	.08	.085
484,000 sq.ft. waterproofing	.0951	.085	.07	.08
23,100 lin.ft. gunite protection	1.86	1.50	1.50	1.70
17,000 cu.ft. conc. protection	1.15	2.00	1.50	1.10
1,000 lin.ft. 3-in. dia. w. i. conduit	2.90	5.00	1.00	3.30
600 lin.ft. 3-in. dia. w. i. conduit	2.35	2.50	1.00	2.70
16,000 lin.ft. 3-in. dia. steel conduit	1.19	1.25	1.00	1.35
600 lin.ft. 2-in. dia. w. i. conduit	1.87	2.00	.50	2.20
12,200 lin.ft. 2-in. dia. steel conduit	.78	.80	.50	.90
6,900 lin.ft. 1¼-in. dia. conduit	.99	1.00	1.00	1.10
400 lin.ft. 1½-in. dia. conduit	1.47	1.50	.75	1.60
245 expansion fittings, 3-in. dia. conduit	27.57	30.00	25.00	30.00
200 expansion fittings, 2-in. dia. conduit	12.75	15.00	10.00	15.00
81 lin.ft. light standards, furnish-install	383.00	350.00	335.00	375.00
63 lin.ft. light brackets	37.00	20.00	30.00	38.00
5 lin.ft. light standards, furnish-delivered	350.00	325.00	300.00	300.00
5 lin.ft. light brackets	33.00	15.00	25.00	25.00
15 fire alarm and telephone posts, install	477.00	100.00	450.00	440.00
3 fire alarm and telephone posts, furnish-delivered	435.00	900.00	350.00	350.00
9,400 lin.ft. underground cable—F.A. system	.36	.35	.32	.40
5 direction signs, furnish-install	405.00	100.00	350.00	400.00
1 direction sign-delivered	355.00	80.00	250.00	307.00
1 traffic signal booth, bronze	2,630.00	2,000.00	2,300.00	2,750.00
1 traffic signal booth, c.i. steel	1,000.00	750.00	600.00	1,000.00
Painting (lump sum)	45,000.00	34,000.00	40,000.00	31,000.00
56,000 sq.yd. granite block pavement	6.40	6.00	6.18	5.25
Totals	$1,476,585	$1,479,578	$1,551,103	$1,563,937

The roadway floor slab of the main roadway, 7½ in. thick, being relatively thin, special provisions pertaining to manufacture, placing and curing of the concrete were inserted in the specifications. A 1 : 2 : 4 mix based on dry materials is specified. No concrete is to be placed when the temperature is below 32 deg. F. and concrete may be placed between 32 and 40 deg. only when the temperature is rising and continued mild weather is predicted and under the following conditions: The water used for concrete shall be heated to an approved temperature; the aggregate shall be heated sufficiently to remove all frost and ice, and the concrete at the time it is mixed and deposited on the work shall have a temperature of not higher than 100 deg. nor lower than 50 deg. F. No salt or mixture of any kind shall be added to the concrete to prevent freezing. The slab is to be kept wet for at least seven days by laying two thicknesses of burlap on it, when in condition to receive it, and applying water.

The roadway pavement adopted was a 4-in. granite-block pavement on a mortar bed. This was chosen because of its durability under expected traffic conditions as well as for its traction qualities in all kinds of weather and its ability to withstand successfully the stresses developed by the deflection of the steel frame and temperature expansion and contraction, thus practically eliminating any maintenance requirements.

The items for the completion of the

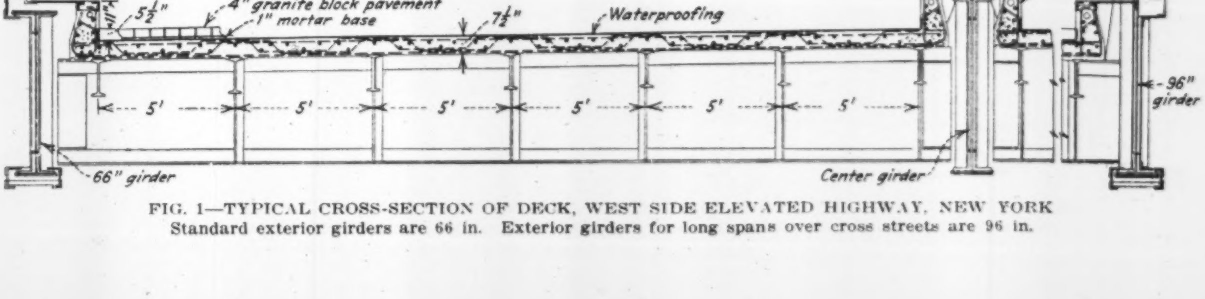


FIG. 1—TYPICAL CROSS-SECTION OF DECK, WEST SIDE ELEVATED HIGHWAY, NEW YORK
Standard exterior girders are 66 in. Exterior girders for long spans over cross streets are 96 in.

ramps at Canal and West 20th Sts. include as a part of the work the construction of granite-faced walls. On the Canal St. ramp a large part of the granite masonry is carved to appropriate designs, developed by the architects, Sloan & Robertson.

The lower flanges of all longitudinal girders are gunited between ornamental angles forming a facia, and all columns are filled with concrete, finishing flush with the ornamental angles furnished thereon. All exposed steel and other surfaces are to be painted. The work is to be carried out under the direction of C. M. Pinckney, chief engineer for the Borough of Manhattan.

The tabulation lists the bids of the lowest four bidders: (A) James Stewart & Co., Inc., 230 Park Ave.; (B) Poirier & McLone Corp.; (C) Remo Engineering Corp.; (D) P. T. Cox Contracting Co.

Storm Sewers in Austin, Tex.

CONTRACT 12 for storm sewers in Austin was awarded in March to the Dellone Construction Co., Allen Bldg., Dallas, for *$32,272*, the lowest of five and 5 per cent below the average. All pipe 30-in. or more furnished by the city. The unit prices of the lowest three bidders are given in the tabulation: (A) Dellone Construction Co.; (B) Dallas Construction Co.; (C) Central Contracting Co., Dallas.

		A	B	C
1,000 cu.yd. rock excav.		$3.00	$3.00	$3.85
2,500 cu.yd. earth excav.		.60	.75	.72
3,400 cu.yd. earth excav.		.80	1.00	1.00
42-in. mono. conc. pipe.	Depth, Ft.			
640 lin.ft. 65x108-in. rect. box	....	16.00	18.00	....
200 lin.ft. 52x108-in. rect. box	....	14.00	16.00	14.57
100 lin.ft.	0– 6	5.50	5.50	5.26
265 lin.ft.	6– 8	6.00	6.00	5.81
210 lin.ft.	8–10	6.60	6.50	6.40
125 lin.ft.	10–12	7.40	7.00	6.68
36x40-in. rect. box				
100 lin.ft.	0– 6	6.50	5.50	6.50
265 lin.ft.	6– 8	7.20	6.00	7.08
210 lin.ft.	8–10	8.00	6.50	7.65
125 lin.ft.	10–12	9.00	7.00	7.97
50 lin.ft. 8-in. pipe	0– 6	.90	.75	1.00
35 lin.ft. 24-in. pipe	0– 6	2.40	2.30	3.35
175 lin.ft. 30-in. pipe	0– 6	1.75	1.40	1.86
150 lin.ft. 30-in. pipe	6– 8	2.20	1.60	2.14
50 lin.ft. 30-in. pipe	8–10	2.75	1.90	2.42
21 lin.ft. 36-in. pipe	0–10	2.20	2.27	4.00
12 lin.ft. 18-in. pipe	0– 6	1.60	1.59	4.31
Totals		$32,272	$33,751	$34,139

Concrete Pavement in San Diego

SAN DIEGO Common Council opened bids May 5, 1930, on 109,071 sq.ft. of 6-in. concrete paving in Tennyson and Sterne Sts., including sidewalk, curb and some sewer work. Five bids were received, with a spread of 5 per cent between low and average. The tabulation gives the unit prices of the lowest two bidders: (A) Griffith Co.; (B) Daley Corp. H. W. Jorgensen is city engineer.

	A	B
4,937.7 cu.yd. excav	$0.55	$0.44
167.5 cu.yd. embankment	0.01	0.015
109,070.7 sq.ft. 6-in. conc. paving	.17	.165
109,070.7 sq.ft. prepared subgrade	.015	.02
11,441.6 sq.ft. sidewalk	.16	.175
311.2 lin.ft. 6-in. curb	.40	.625
2,234.5 lin.ft. 8-in. curb	.60	.55
241 ft. 4-in. Class B c.i. main	1.00	1.33
565 ft. 8-in. Class B c.i. main	1.70	2.12
95—¾-in. water services	19.60	23.25
29—4-in. conc. sewer laterals	30.00	34.90
37—6-in. conc. sewer laterals	30.00	35.80
Totals	$31,516	$32,149

Bids for the Jones Beach boardwalk were for untreated and treated timber, as noted here on April 24, 1930, p. 710. The Wolman salt treatment or equal was specified. Contract was awarded to Graves-Quinn Corp., and the treatment will be zinc meta-arsenite and done at the Long Island City plant of Eppinger & Russell Co., the subcontractor.

Concrete, C.I., and V.C. Pipe in Louisiana

BIDS were opened March 5, 1930, and contract awarded for a sanitary sewer system for Gretna, La., to cost $308,754. Alternate bids were asked on reinforced-concrete and vitrified-clay pipe. Sizes range from 6-in. to 36-in., the depths from 4 to 18 ft. Considerable cast-iron pipe also is included. The accompanying tabulation lists the pipe price of the lowest three bidders: (A) M. Mitchell & Sons, 323 Saratoga St., New Orleans (contract price $308,754 for concrete); (B) H. W. Bond & Bro., $325,686; (C) John J. Quinn Co., $349,140. W. H. Vincent is city engineer. The total bids for the alternates were:

	Concrete	Clay		Concrete	Clay
A.	$308,754	$313,516	D.	$349,472	$353,892
B.	325,686	328,474	E.	372,160	373,345
C.	349,140	351,891	F.	379,370	384,214
Average				$347,400	$350,900

Increase for V. C., 1 per cent.

UNIT PRICES OF LOWEST THREE BIDS

	Depth, Ft.	Lin.Ft.	A	B	C
36-in. reinf. con. pipe	14–16	425	$12.98	$9.20	$11.50
36-in. reinf. con. pipe	16–18	400	13.24	9.60	13.50
36-in. cast iron pipe	18–20	50	20.50	24.60	20.50
36-in. cast iron pipe	16–18	175	20.00	24.10	18.00
30-in. reinf. conc. pipe	14–16	925	9.55	8.00	9.50
27-in. reinf. conc. pipe	14–16	1,500	7.93	6.41	8.25
24-in. reinf. conc. pipe	14–16	650	7.14	5.25	7.95
24-in. reinf. conc. pipe	12–14	2,850	6.50	5.05	7.45
24-in. cast iron pipe	14–16	200	12.56	12.90	12.00
21-in. reinf. conc. pipe	12–14	600	6.03	5.65	7.25
18-in. reinf. conc. pipe	12–14	1,550	4.75	7.75	7.00
18-in. reinf. conc. pipe	10–12	1,225	3.52	2.55	6.00
18-in. T.S. vitrified clay pipe	10–12	1,225	4.38	3.00	6.46
18-in. reinf. conc. pipe	8–10	1,700	3.18	2.45	5.50
18-in. T. S. vitrified clay pipe	8–10	1,700	4.06	2.95	5.96
18-in. reinf. conc. pipe	6– 8	350	2.09	2.00	4.90
18-in. T.S. vitrified clay pipe	6– 8	350	2.93	2.45	5.36
16-in. cast iron pipe	10–12	50	6.38	7.85	10.00
16-in. cast iron pipe	8–10	50	5.92	7.75	9.50
15-in. conc. pipe	10–12	775	3.15	2.60	4.75
15-in. D.S. vitrified clay pipe	10–12	775	3.31	2.70	4.87
15-in. conc. pipe	8–10	2,300	2.27	2.20	3.25
15-in. D.S. vitrified clay pipe	8–10	2,300	2.43	2.30	3.37
15-in. conc. pipe	6– 8	1,000	1.86	1.95	2.90
15-in. vitrified clay pipe	6– 8	1,000	2.03	2.00	3.02
12-in. conc. pipe	12–14	225	2.34	2.20	4.90
12-in. D.S. vitrified clay pipe	12–14	225	2.44	2.30	4.99
12-in. conc. pipe	10–12	700	2.19	2.10	4.50
12-in. D.S. vitrified clay pipe	10–12	700	2.31	2.18	4.59
12-in. conc. pipe	8–10	2,700	1.96	1.90	2.50
12-in. D.S. vitrified clay pipe	8–10	2,700	2.08	1.98	2.59
12-in. conc. pipe	6– 8	1,300	1.54	1.50	2.00
12-in. D.S. vitrified clay pipe	6– 8	1,300	1.66	1.62	2.09
12-in. cast iron pipe	10–12	50	4.88	6.10	6.00
12-in. cast iron pipe	8–10	100	4.53	6.00	4.00
12-in. cast iron pipe	6– 8	50	3.86	5.58	3.75
10-in. conc. pipe	10–12	1,100	2.09	2.20	3.35
10-in. vitrified clay pipe	10–12	1,100	2.20	2.28	3.40
10-in. conc. pipe	8–10	2,175	1.70	1.90	2.50
10-in. vitrified clay pipe	8–19	2,175	1.81	1.98	2.55
10-in. conc	6– 8	2,550	1.08	1.20	1.75
10-in. vitrified clay pipe	6– 8	2,550	1.19	1.28	1.80
10-in. conc. pipe	4– 6	300	0.51	1.25	1.25
10-in. vitrified clay pipe	4– 6	300	0.61	1.10	1.32
10-in. cast iron pipe	10–12	50	4.06	5.63	5.50
10-in. cast iron pipe	8–10	100	3.52	5.55	3.50
10-in. cast iron pipe	6– 8	50	3.11	5.15	3.00
8-in. vitrified clay pipe	10–12	350	1.99	1.25	3.31
8-in. vitrified clay pipe	8–10	2,700	1.75	1.20	2.51
8-in. vitrified clay pipe	6– 8	23,600	1.33	0.85	1.11
8-in. vitrified clay pipe	4– 6	65,300	0.52	0.75	0.91
8-in. cast iron pipe	8–10	100	2.07	5.43	2.50
8-in. cast iron pipe	6– 8	200	2.55	6.20	2.00
6-in. vitrified clay pipe	4– 6	7,800	0.22	0.50	0.83
		Each			
Brick manholes, complete	4– 6	125	70.00	84.00	60.00
Brick manholes, complete	6– 8	116	98.00	140.00	65.00
Brick manholes, complete	8–10	40	126.00	155.00	80.00
Brick manholes, complete	10–12	23	154.00	190.00	90.00
Brick manholes, complete	12–14	15	182.00	240.00	115.00
Brick manholes, complete	14–16	6	210.00	300.00	125.00
Brick manholes, complete	16–18	1	238.00	475.00	145.00
Brick manholes, complete	18–20	2	266.00	500.00	200.00
		Lb.			
Deformed reinforcing bars	.....	1,000	0.05	0.05	0.08
		Cu.Yd.			
Extra excav, over	16	300	2.50	2.00	3.00
Extra excav., under	16	300	2.50	0.70	2.00
Foundation lumber under sewers, laid longitudinally	.....	Ft. B.M. 30,000	45.00	56.00	45.00
Foundation lumber under sewers, laid transversely	.....	90,000	55.00	55.00	50.00
		Cu.Yd.			
Clamshells, furnished and placed	.....	2,000	4.00	5.00	3.50
Furnish, haul, unload and lay 24-in. cast iron force main	.....	4,200	7.90	12.30	9.00
Furnishing and setting 24-in. horizontal valves	.....	Each 2	492.50	600.00	400.00
		Lin.Ft.			
Creosoted round piling	.....	1,700	1.74	2.00	1.50
Complete construction of sewer pumping station No. 1	.....	.....	11,980.81	11,784.00	9,500.00
Totals			$308,754	$325,686	$349,140